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GEOLOGY AND CHEMISTRY[1]

By Professor NORMAN L. BOWEN

THE UNIVERSITY OF CHICAGO

WE are here to-day with the pleasant duty of dedicating a splendid new building to the service of chemistry and geology. Some of you may have been led to wonder at the housing together under one roof of two sciences that are often placed in opposed categories, the one an experimental science, the other a natural science. But is it, after all, so strange a union?

Chemistry had a utilitarian beginning. It grew out of the attempts of man to convert natural materials to his uses. The first chemical process consciously employed was probably the process of combustion. Fire was to early man, as it is to us to-day, of outstanding importance, and one of its earliest services was that of reducing metals from their ores. A primitive hunter kindled a fire in the lee of a rusty boulder and was astounded to find in the ashes glistening pellets that he could shape at will by pounding them with a stone. From this beginning he and his fellows learned to associate the production of this lustrous, malleable material with the bringing together of fire and a certain kind of rock substance. When they wished more of that material, for which they found many uses, they learned to seek other occurrences of similar rock to be fired in a similar manner. The production of metals from natural rock substances was at first no more than a craft. But man does not long remain content with wholly utilitarian pursuits, else we should not find among primitive peoples the remarkable knowledge of such matters as the motions of heavenly bodies. Our nimrod metallurgist soon began to ponder upon the fundamental nature of his craft. In this act the science of chemistry was born, but no less also was the science of geology born, if indeed any purpose is served by attempting to classify the trains of thought instituted in those unpracticed minds. The desire to understand the real nature of the raw material, to grasp why it

[1] Address given at the dedication of the new Science Building of Bryn Mawr College, October, 22, 1938.

occurred in some places and not in others, knowledge which we should now call geological, must have been just as great as the desire to understand the process to which he subjected it and the product which he gained, nowadays chemical knowledge. It was all one problem. Increased knowledge of one aspect could not fail to shed light on other aspects. This condition persisted as knowledge advanced along these lines. One investigator engaged in all the necessary pursuits. Classification of activities was not emphasized and the broad general view prevailed well into the comparatively recent period during which the principal advances in chemical knowledge consisted in the progressive discovery of the elements. This was but natural, since they were found for the most part through the treatment of new raw materials, and each discovery threw new light on a naturally occurring substance. The system of knowledge that developed was regarded as a unit, and given the name "natural philosophy."

As the system grew, it was inevitable that some philosophers should pay greater attention to certain aspects of it. In the laboratory the investigator produced new compounds from old compounds and still newer compounds from these again, until finally he had substances so many steps removed from the natural raw materials that he might easily forget his ultimate dependence upon such materials. Thus there tended to grow up laboratory science as distinct from natural science and the connection between them was often temporarily lost to view. With what force must Marie Curie have been reminded of this connection when, with an electroscope of Pierre's construction, she examined a long series of geological specimens to determine what minerals emitted the mysterious Becquerel rays, and then, confining her efforts to the most promising material, she set to work in an old, draughty shed to treat ton after ton of a waste product of Bohemian uranium ores and isolated the astounding new element, radium. Her discovery revolutionized chemistry; it revolutionized geology, giving, for example, a wholly new vista of geologic time; it revolutionized all science. Just so thin, so unreal are the barriers between the sciences.

In their common interest in their common materials geology and the laboratory sciences tend to grow hand in hand. Chemists and physicists continue to discover new elements and new isotopes of the elements. The materials they treat come from the earth, and in their original home have long been studied by the geologist. Investigation of the chemical characters of minerals, rocks and ores, whether undertaken for utilitarian ends or with these fundamental problems of the constitution of matter in mind, will ever be an indissoluble bond between chemistry and geology—but it is not enough.

Geological science is not concerned solely with the nature of the materials of the earth. Geology is even more concerned with processes, with the changes to which earth materials have been subjected. It seeks to know not only what earth substances are, but how they have come to be what they are, what factors have led to the observed arrangements and associations. Such knowledge is the special domain of geology. Overlap into the fields of other branches of science is here not so obvious. The chemist may readily find it essential to the advance of his science to institute a study of the mineral pitchblende, but he is very unlikely, of his own accord, to investigate the chemical action of atmospheric ingredients upon the various constituents of rocks. He will ordinarily realize the importance of such studies only when the geologist points out to him the cumulative magnitude of such action in nature and then urges upon him the significance to both chemistry and geology of an exact knowledge of the processes involved. Absorbed in his own science the chemist might ordinarily never even realize the existence of such a phenomenon as rock weathering; yet, induced to study it, he might make discoveries of general significance to such problems as rates of reaction, adsorption by surfaces, formation of colloids and others destined to enrich scientific knowledge as a whole.

The weathering of rocks is only one of a great host of geologic processes, all of them chemical and physical processes occurring in or upon the earth, the true nature of which the geologist must seek to unravel. As a check upon his deductions regarding their nature it is in all cases most desirable that experimental studies be carried out under controlled and measured conditions and the actual importance of the various factors involved be thus ascertained.

At the risk of being technical and tedious it may be appropriate to point out very briefly a few of the many directions in which chemical studies have thrown or may be expected to throw new light on geological processes, with consequent enlargement of the domain of chemical science itself. Geologic processes may be regarded as beginning with the high-temperature phenomena. Some aspects of these are revealed in the outpourings of lava from volcanoes that have occurred throughout geologic time and have been observed by man with wonder and awe ever since he made his first appearance on the planet. Molten lavas solidify on cooling and ordinarily give rise to a crystalline aggregate of a number of different minerals, an igneous rock. The study of the manner in which minerals form from molten mixtures has now been carried on for some time. It constitutes a special branch of high-temperature chemistry or physical chemistry and has served to throw much light upon the temperatures prevailing and the processes at work during the con-

solidation of masses of molten rock. At the same time chemistry extended its domain and many facts came to light that are of fundamental significance to certain branches of the chemical industry, such as the manufacture of glass, cement and refractories.

In spite of notable progress in these laboratory investigations of igneous-rock formation much remains to be accomplished. The most superficial observer of volcanic eruptions realizes that the lavas poured out are not simple melts but that they contain dissolved in them many substances which are gaseous at the high temperatures prevailing. Investigation proves that the principal of these is water, but many others are present, among which may be mentioned chlorine, fluorine, sulfur. To the presence of these substances volcanic activity owes its frequent explosive character, and their reactions with each other and with the less fugitive constituents of the lavas are of great importance to an understanding of volcanic phenomena. The investigation of these reactions in the laboratory is a special field of high-temperature and high-pressure chemistry that is warranted to tax the ingenuity of the most accomplished experimenter, and the theoretical treatment of the results will require a most facile mind. If the reward is measured by obstacles overcome, a generous reward awaits the successful experimenter in this field. Significant results have already been obtained, but they serve principally to whet the appetite for more.

In discussing high-temperature geologic processes it is but natural to begin with those that are manifested directly upon the surface of the earth. At the same time it should be realized that the lava poured out during a volcanic eruption is ordinarily but an insignificant spurt from a large reservoir of molten rock existing at considerable depth within the earth and that this large mass itself cools and crystallizes with the passage of time. Thus have arisen many deep-seated masses of igneous rock. Frequently these have been laid bare as a result of the wearing away of mountains by streams, with consequent exposure of the "roots" of the mountains at the surface of the earth. The geologist is thus enabled to study the products of the aeon-long cooling of molten masses of rock, and these, not lavas, are the most important and the most abundant of the primary or igneous rocks. He finds here many interesting contrasts with the same materials when cooled quickly as surface lavas. Instead of making violent escape from the magma it is apparent that the volatile constituents, for the most part, remained in solution in the melt when it thus cooled under a considerable cover of overlying rocks. The volatile constituents were therefore enabled to exert important influence upon the crystallization of the magma. In large measure they remained in solution until late stages of crystallization and thus attained high concentrations in the residual liquids. In part they entered into the composition of the later-formed minerals. In part they escaped into surrounding rocks as liquid or gas and carried with them in solution many substances that were concentrated with them. These they often deposited at favorable localities in the surrounding rocks, and thus arose many of our most valuable ore deposits.

This is the general story of the formation of such deposits, as deciphered by the geologist from their field relations. The full details of the process and decision upon many moot points can be had only as a result of properly designed laboratory experiments. Such work constitutes a field of moderate-temperature, moderate-pressure chemistry of solutions of most complex character. Something has been accomplished in the field, but progress in it lies in the development of new techniques. Critical phenomena will be encountered and most complex relations between the various states of matter. The requirements are most exacting, the promise of results of general significance is great. The field should prove attractive to the chemical investigator.

At an earlier point I have mentioned the problem of rock weathering and its challenge to the chemist. From the moment a rock is exposed at the surface it suffers attack both mechanical and chemical, actions which, as we have seen, are susceptible of laboratory investigation. Running water transports the products of decomposition, partly in suspension, partly in solution. Broadly speaking, their ultimate destination is in the sea, where some remain in solution and are there building up to higher and higher concentrations with the passage of the ages, and others are deposited upon the sea floor as mechanical or chemical sediments. The mechanical sediments are sands and muds, and on first thought it might seem that their deposition presents no chemical problems. Yet closer examination reveals that this is far from the truth. Precipitation is in some measure related to the degree of concentration of electrolytes in solution, fine particles adsorb salts and do so selectively, so that even the detrital sediments raise many chemical questions.

Such questions are, of course, paramount for chemical sediments, the most important of which is perhaps limestone, though by no means all limestones are simple chemical precipitates. The chemistry of the formation of this common rock still presents many unsolved problems. There are other, less common chemical deposits of great interest. In some circumstances many substances of relatively low solubility in sea water have been deposited from it as extensive beds. Silica as beds of chert and silica interlaminated with iron oxides are prominent examples. To the rework-

ing of the latter we owe the great bodies of iron ore in the Lake Superior region. Beds of calcium phosphate have also been formed, and they have great importance as a source of fertilizer. The special conditions under which these diverse materials are separated from sea water are at present not much more than a matter of conjecture and they will remain so until they have received adequate chemical investigation.

No purpose can be served by multiplying examples, but it would be an ill-balanced discussion of our present topic which failed to mention salt deposits. In the never-ending movements of the body of the earth, and consequent warping of its surface, it sometimes happens that arms of the sea are cut off and are subjected to slow evaporation. Under these conditions even the very soluble salts have been deposited and thus have arisen many salt and gypsum beds and, in extreme cases, beds containing potassium and magnesium salts. A laboratory investigation by Van't Hoff of the conditions of formation of these several deposits is a chemical classic.

All these processes of weathering, transportation and deposition of substances belong to a field of chemistry of ordinary temperatures and pressures. Laboratory investigation of them requires a minimum of apparatus and equipment and for the most part familiar techniques. A vast field is open.

Geology, we have seen, is concerned with the materials of the earth and with the processes that have wrought changes in these materials and we have striven to show how both these aspects of the science are connected with the science of chemistry. Geology has yet another aspect. It is concerned with the inhabitants of the earth, the various forms of life that have existed upon it and with the conditions under which they lived. The connection between geology and biology is here the more obvious one, yet we can not think of the environment of life through the ages without regard for its chemical aspects. Changes in the character of sea water and of the atmosphere are of great importance, and much chemical and biochemical research with an eye to geologic interpretation remains to be accomplished here. Living organisms have, too, contributed great deposits to the geologic column, the most significant, perhaps, limestone and coal. The chemistry of the processes involved, say in the development of coal from plant remains or in the development of petroleum, still requires much research for its elucidation. Limestone and coal have been listed among the five or six fundamental raw materials of the chemical industry, and even one engaged in the most abstruse research in pure chemistry should not be utterly oblivious to chemical industry's raw materials and the problems which they pose. Here again there is opportunity for collaboration between geology and chemistry.

Enough has been said to make it clear that each of the three major aspects of geology presents problems where chemistry and geology come together upon common ground. How appropriate it is then to bring these sciences together under one roof! As much could be said for housing physics and geology together, but it is, for the most part, unnecessary to say it. Cooperative efforts of physics and geology have in the recent past proven so fruitful in a commercial way that it is relatively easy to arouse interest in and obtain support for such investigations, even when extended to what might be termed problems of pure geology. Indeed, plans for extensive geophysical research in pure geology are now being pushed with great vigor. Such research has the great advantage, or should I say the seeming advantage, of great general appeal. What could be more stirring than artificial earthquakes, than weighing the earth or than boring holes in the bottom of the sea? In such work explanation is sought of such large-scale phenomena as thrustings of the earth's crust, changes in the level of the sea and many others. It has great promise and every effort is justified, yet it is possible that these actions have their ultimate origin in changes of phase equilibria within the earth, dominantly a chemical phenomena, if indeed we should here draw any boundary line. And if the good ship *Geophysica* should outsail her sister ship *Geochemica* she will soon find that she is off her course, that she can not hope to make port but must put about and join her sister. Together they can continually correct the course and sail on with confidence.

So, though the grouping of physics and geology would be entirely appropriate, I believe the grouping of chemistry and geology has its advantages in these times. Physics is here housed with biology. They have, I need hardly say, much common ground, and their grouping may lead to cooperation between branches which would otherwise go their separate ways. And when we have said these things we can not fail to be brought to a realization of the artificial nature of *any* particular grouping, of the arbitrary character of the boundaries that have been set up in science and of the essential unity of all science, a unity more fully appreciated in earlier days than in these days of extreme specialization. His own realization of this fact and his conviction that great benefit would accrue to science if this realization were more general are, no doubt, the factors that led Professor Tennent to formulate his plan of balanced instruction in science, without extreme specialization at the undergraduate level, a plan which the administrators of this college have wisely adopted. Many colleges turn out geologists with no more than a smattering of chemistry, and many turn out chemists altogether devoid of geological knowledge. Often enough the deficiency may not be a

serious barrier to material success in either case, but surely we can not measure the value of an education solely by its prospect of material success. The broadening of interests that results from a well-rounded training may well lead to comparative indifference to material success and thus to a life in which there is time to observe our surroundings and to contemplate upon their meaning. The scientific outlook is not likely to be gained from too great and too early specialization in science with its feverish acquirement of techniques, but rather from a broad, general training in science; and the scientific outlook on life and living is sorely needed in these days of heated passions and rampant prejudices.

Yes, broad undergraduate training in science should be a valuable preparation for living. The exigencies of college curricula ordinarily make it necessary that the undergraduate training be also a preparation for specialization. Will such specialization be handicapped because the preparation was so broad that it could not be deep? Probably not. The specialist can benefit greatly from knowledge of other fields. More and more does one branch of science depend upon borrowing from other branches. As a result have grown up special branches that have been termed borderland sciences and have received names that emphasize that character. Among them there are biophysics and geophysics, biochemistry and geochemistry. The last is born of the union of geology and chemistry, the two subjects of which our building is to be the home. We have considered something of what has been accomplished and what we may look for in the field that is common to these two sciences, and in general it may be said that the major advances in the great natural sciences biology, geology, astronomy must come through the development of the borderlands where they march against chemistry, physics and mathematics. The past has been mainly a period of fact-finding, but science can be stifled by facts. It is only when processes are considered and properly understood that a horde of little facts becomes a single great fact and real scientific progress is made. The natural sciences have generalizations of surpassing grandeur that are truly their own; but it now seems that further generalizations will arise dominantly through development of their borderland fields.

The worker who prepares himself especially for investigation in the borderland between chemistry and geology may expect a singularly attractive existence. To-day he is in his laboratory making careful measurements and obtaining results the probable error of which he can state within certain definite limits, a condition that is most satisfying to the scientific type of mind. But confinement between four walls, close application and a sedentary existence eventually pall, and to-morrow he is in the great out-of-doors observing natural processes and their results, probing for the fundamentals of these processes, yet ever finding that too many questions remain unanswered. Whereupon he returns to his laboratory with increased vigor and renewed hope that he can there find some of the answers. He thus leads a double life, a very satisfactory double life.

There is need for men and women trained for this border field. It should not be necessary for the geologist to come hat in hand to the chemist's door and beg his advice and cooperation in the solution of a geochemical problem, only to be turned away, partly because he is unable to present his plea in a language intelligible to the chemist, and partly because there is currently too great a tendency to regard such collaboration as savoring of the famed collaboration between the monkey and the cat in the incident of the chestnuts, with the chemist in the rôle of the cat. No, chemistry has itself profited greatly from its efforts to aid geology, but since the impression noted is all too prevalent it is the more necessary that we should have an increasing number of workers trained in both geology and chemistry. To such workers the geologist proper may turn with confident expectation of sympathetic understanding. Extreme specialists in chemistry on the one hand and in geology on the other will still be needed as contributors to borderland activities. The man of dual training who spreads his energies over both fields can not hope to be absolute master of both, but will find it necessary to call such specialists to his aid. In particular he should be most effective in a liaison capacity, by making possible a collaboration between a chemist and a geologist who, without his aid, would be unable to get together upon common ground.

In this college it is definitely planned to coordinate the teaching of the sciences in such a way as to facilitate training in several border zones between the sciences, among them that between geology and chemistry. All honor to Bryn Mawr for its pioneer work in such development. Hitherto it has usually been necessary for the student himself to visualize the need for such dual training and to lay his plans accordingly, often to encounter many difficulties on account of the existing arrangements. Here the student will be set upon the right path and the path will be smoothed. Proximity is a potent influence in affairs of the heart. May it prove to be as potent in affairs of heart and mind, and may the common domicile of chemistry and geology further the schemes of Matchmaker Tennent and conduce to the development through the years of a succession of workers in the enticing borderland between these sciences, much needed for the balanced development of both of them.

RACIAL THEORIES AND THE GENETIC BASIS FOR DEMOCRACY[1]

By Secretary HENRY A. WALLACE
UNITED STATES DEPARTMENT OF AGRICULTURE

ON this particular anniversary of the birth of Abraham Lincoln it is especially fitting that scientists should gather together. At this meeting and at other meetings throughout the country, men of science are met to rededicate themselves to the principles of liberty on which their profession is based. The cause of liberty and the cause of true science must always be one and the same. For science can not flourish except in an atmosphere of freedom, and freedom can not survive unless there is an honest facing of facts in the scientific spirit of men continually seeking the truth.

Numerically, the workers in the field of science are not a large group. But, as leaders and moulders of thought, they play an exceedingly important part in the life of our nation and of the world. And so I want to pay tribute to the leadership of Professor Boas, who, as chairman of the "Lincoln's Birthday Committee for Democracy and Intellectual Freedom," has done so much to marshal the moral forces of science in this great cause.

The immediate reason for your meeting to-day is the profound shock you have had, and the deep feeling of protest that stirs in you, as you think of the treatment some of your fellow scientists are receiving in other countries.

Men who have made great contributions to human knowledge and culture have been deprived of their positions and their homes, put into concentration camps and driven out of their native lands. Their life work has been reviled.

In those same countries, other men, who call themselves scientists, have been willing to play the game of the dictators by twisting science into a mumbo-jumbo of dangerous nonsense. These men are furnishing pseudo-scientific support for the exaltation of one race and one nation as conquerors.

These things run counter to your whole tradition as scientists. You are not only amazed and shocked and moved to protest against the fate of your fellow scientists abroad. You shudder with the realization that these things have happened in scientifically advanced countries in the modern world—and that they might happen here.

Probably because I myself have been much interested in the field of plant breeding, I have been asked to speak to-day on the subject of "Racial Theories and the Genetic Basis for Democracy."

Claims to racial superiority are not new in the world. Even in such a democratic country as ours, there are some who would claim that the American people are superior to all others. But never before in the world's history has such a conscious and systematic effort been made to inculcate the youth of a nation with ideas of racial superiority as is being made in Germany to-day.

Just what are these ideas? Let me quote from a translation of the "Official Handbook for the Schooling of the Hitler Youth," the organization which includes some 70 per cent. of all the boys and girls in Germany of eligible age.

The handbook discusses the various races found in Germany and other parts of Europe. Concerning what it calls the Nordic race, it says: "Now what distinguishes the Nordic race from all others? It is uncommonly gifted mentally. It is outstanding for truth and energy. Nordic men for the most part possess, even in regard to themselves, a great power of judgment. They incline to be taciturn and cautious. They feel instantly that too loud talking is undignified. They are persistent and stick to a purpose when once they have set themselves to it. Their energy is displayed not only in warfare but also in technology and in scientific research. They are predisposed to leadership by nature."

But here is what the handbook says concerning what it calls the "Western Race," found principally in England and France: "Compared to the Nordic race there are great differences in soul-qualities. The men of the Western race are . . . loquacious. In comparison with the Nordic . . . men they have much less patience . . . They act more by feeling than by reason . . . They are excitable, even passionate. The Western race with all its mental excitability lacks creative power. This race has produced only a few outstanding men."

That is the end of the quotation.

Thus the dictatorial régime in Germany, masquerading its propaganda in pseudo-scientific terms, is teaching the German boys and girls to believe that their race and their nation are superior to all others, and by implication that that nation and that race have a right to dominate all others.

That is the claim. What ground does it have in scientific fact?

We must remember that down through the ages one

[1] Address at the public meeting sponsored by the "Lincoln's Birthday Committee for Democracy and Intellectual Freedom," held in the Grand Ballroom of the Waldorf-Astoria Hotel, New York City, on Sunday afternoon, February 12. Broadcast over Red Network of the National Broadcasting Company from 2 to 2:30 P.M., originating from station WEAF, New York City.

of the most popular political devices has been to blame economic and other troubles on some minority group. But no one can claim with scientific certainty superiority for any race or nation so far as its inborn genetic characteristics are concerned.

Indeed no nation in Europe is a greater mixture of tribes and breeds than the Germans. This is of course nothing against them, but it makes absurd the claims of superior stock. The word Aryan as used by scientists and not by dictators means the people of the Caucasian race who speak one or another of the Indo-European languages. (Any one can look it up in his dictionary.) Jews are of course Aryans, so are Hindus, so are Germans and French and English and most Americans. The dictators' misuse of the word Aryan is pure scientific faking.

Two thousand years ago there was nothing about the ancestors of the modern English or Germans to indicate either scientific, artistic, inventive or philosophic ability. Neither their traditions nor their economic opportunities permitted development along these lines. No scientist can say to-day with any certainty that many of the so-called backward races and nations do not have inborn genetic capacity which might flower unusually in the sciences, the arts or philosophy, provided only economic conditions and social institutions permitted.

When I was a small boy, George Carver, a Negro who is now a chemist at Tuskegee Institute, was a good friend of my father's at the Iowa State College. Carver at that time was specializing in botany, and he would take me along on some of his botanizing trips. It was he who first introduced me to the mysteries of botany and plant fertilization. Later on I was to have an intimate acquaintance with plants myself, because I spent a good many years breeding corn. Perhaps that was partly because this scientist, who belonged to another race, had deepened my appreciation of plants in a way I could never forget.

Carver was born in slavery, and to this day he does not definitely know his own age. In his work as a chemist in the South, he correctly sensed the coming interest in the industrial use of the products of the farm—a field of research which our government is now pushing. I mention Carver simply because he is one example of a truth of which we who meet here to-day are deeply convinced: Superior ability is not the exclusive possession of any one race or any one class. It may arise anywhere, provided men are given the right opportunities.

It is the fashion in certain quarters to sneer at those so-called "poor whites," who suffer from poor education and bad diet and who live in tumble-down cabins without mattresses. And yet I wonder if any scientist would care to claim that 100,000 children taken at birth from these families would rank any lower in inborn ability than 100,000 children taken at birth from the wealthiest one per cent. of the parents of the United States. If both groups were given the same food, housing, education and cultural traditions, would they not turn out to have about equal mental and moral traits on the average? If 100,000 German babies were raised under the same conditions as 100,000 Hindu babies or 100,000 Jewish babies, would there be any particular difference? No such experiments have been made or are likely to be made and so no absolutely scientific answer can be given. But when I raise such a question, I mean to imply that every race, every nation and people from every economic group of society are a great genetic mixture. There is far greater variability between the heredity of individuals within the groups than between the groups. There may be a certain amount of stability of type with regard to skin and eyes and hair, but with regard to mental and emotional characteristics there is very little evidence of genetic uniformity for any race or nation. There may be a great deal of uniformity with respect to traditions but not with respect to complex hereditary characters.

In all this I do not mean to say that heredity does not work with human beings just as truly as it does with plants and animals. Nor do I mean to deny that a master breeder living for a thousand years might do extraordinary things in the way of fixing human types of unusual longevity, resistance to disease, musical ability or any one of a number of characteristics. A master breeder who had a dictator's control for several generations might be able to fix a standard blue-eyed, long-headed, fair-haired type of the most approved Nordic specifications. But from our studies in livestock breeding we know that the more complex characteristics are usually altogether separate from such superficial characteristics as skin, hair or eye color. The color of a cow's hair, for instance, has nothing to do with her ability to produce milk and there is no reason to think that the color of a man's hair has anything to do with his ability to produce ideas. And so it is quite possible that the master breeder, being concerned primarily with physical appearance, would find he had produced a group of blonde morons—useful to him mainly as a superior type of cannon fodder.

On the whole, it seems probable that nowhere in the world in the next couple of centuries will a genuinely scientific attempt, in the sense understood by the plant or animal breeder, be made to breed for superior types of human beings. The different races and nations will continue to be conglomerates with a vast variability of mental and emotional qualities and the other abilities which make for leadership and genius.

Here in the United States, our own population is a blend of many races. Men and women of many races

have built our science, our literature and our art—our finance, our industry and our government. The noblest chapters in our history have been those filled with struggle against tyrannical denial of freedom.

I am convinced, as a result of my study of genetics, that there is nothing in science to interfere with what might be called a genetic basis for democracy. The seed bed of the great leaders of the future, as of those of the past, is in the rank and file of the people.

Environment, of course, will continue to be very important. Because of superior opportunities an undue proportion of our great leaders may perhaps come from the wealthier five per cent. If there is somewhat greater diffusion of opportunity and wealth—if the children of all classes get enough to eat and good schooling—if all children are given an opportunity to realize to the full their inborn faculties to serve the general welfare, we may expect genius to sprout more evenly from all economic classes of society. In a study of human genetics recently made by the National Resources Committee, it was found that among given racial groups, intelligence ratings varied with the environment. Intelligence quotient ratings generally seem to be more a matter of education and upbringing than of heredity.

Just as a favorable environment is needed to help the development of great leaders and great scientists, so a good environment is essential to preserve our liberty. The imperative need is for us to ask ourselves under what conditions our liberty can be lost. Under what conditions do men of the ruthless dictator type rise to power in a modern nation? Under what conditions do they persuade a whole people to accept a philosophy, and to follow a line of action, that violates many of the finest achievements of humanity and exalts many of the worst? Under what conditions are great numbers of men willing to surrender all hope of individual freedom and become ciphers of the state? Under what conditions will the scientist deny the truth and pervert his science to serve the slogans of tyranny? And again, how can those conditions be prevented from occurring in our country?

In seeking to answer these questions honestly, we shall inevitably come upon certain truths that are not flattering to us. We shall find in our own country some of the conditions that have made possible what we see abroad. The seeds of these conditions exist here. It is not enough simply to hope that these conditions will not reach such extremes here as they have in some other countries. We must see to it that they do not.

When a political system fails to give large numbers of men the freedom it has promised, then they are willing to hand over their destiny to another political system. When the existing machinery of peace fails to give them any hope of national prosperity or national dignity, they are ready to try the hazard of war. When education fails to teach them the true nature of things, they will believe fantastic tales of devils and magic. When their normal life fails to give them anything but monotony and drabness, they are easily led to express themselves in unhealthy or cruel ways, as by mob violence. And when science fails to furnish effective leadership, men will exalt demagogs, and science will have to bow down to them or keep silent.

The ironic fact is that the economic maladjustments of the present day which threaten our democracy and the freedom of science are in large part due to the changes wrought by science. In a democracy, every individual according to his station in life and according to his capacity should have opportunity for joyous service of the general welfare. Scientists, by their discoveries and inventions—which in countless ways have enriched our lives—have at the same time, without intending to do so, helped to break down this kind of democracy. Quite without intention, they have helped to replace it with an industrial system in which a small number of individuals make the decisions and the great majority have no feeling that they are taking part according to their capacity on equal terms in a common enterprise. Quite without intention they have helped to build an industrial system in which the security of an earlier day has been replaced with the hazard of unemployment. During 1931 and 1932, many scientists, accustomed to working quietly in their laboratories and with little thought for their own economic security, suddenly found their salaries cut in half or their jobs completely gone. Yes, scientists now know that in their own self-defense their methods in the deepest and most spiritual sense must eventually serve the general welfare in the economic and social world.

And so to-day, on the 130th anniversary of the birth of Abraham Lincoln, it is especially encouraging that science is facing the facts concerning the long-run effects of its own past achievements. It is encouraging that science at last is working actively for economic security and is coming actively to the defense of "government of the people, by the people, for the people."

Democracy—and that term includes free science—must apply itself to meeting the *material* need of men for work, for income, for goods, for health, for security, and to meeting their *spiritual* need for dignity, for knowledge, for self-expression, for adventure and for reverence. ***And it must succeed.*** The danger that it will be overthrown in favor of some other system is in direct proportion to its failure to meet these needs. We may talk all we like about the beauties of democracy, the ideals of democracy, the rightness of democracy. In the long run, democracy or any other political system will be measured by its deeds, not its words.

The survival and the strength of American democracy are proof that it has succeeded by its deeds thus far. But we all know it contains the seeds of failure. I for one will not be confident of the continued survival of American democracy if millions of unskilled workers and their families are condemned to be reliefers all their lives, with no place in our industrial system. I will not be confident of the survival of democracy if economic crises every few years continue to put fear into the hearts of millions of skilled and professional workers. I will not be confident of the survival of democracy if half our people must continue to be below the line of decent nutrition, while only one tenth succeed in reaching really good nutritional standards. I will not be confident of the survival of democracy if most of our children, which means most of our future citizens, continue to be reared in surroundings where poverty is highest and education is lowest.

These are the conditions that made possible what we are now witnessing in certain large areas of the world. They are the seeds of danger to democracy. Given a healthy, vigorous, educated people, dignified by work, sharing the resources of a rich country and sure that their political and economic system is amply meeting their needs—given this, I think we can laugh at any threat to American democracy. But democracy must continue to deliver the goods.

And so, let us dedicate ourselves anew to our democratic body of faith—to the promotion of a stable but ascending general welfare by increasing the productivity of the people and by adopting price, wage and other policies which distribute income more evenly among the people but which do not diminish the incentive to increased production of needed goods. Let us dedicate ourselves anew to the belief that there are extraordinary possibilities in both man and nature which have not yet been realized, and which can be made manifest only if the individualistic yet cooperative genius of democratic institutions is preserved. Let us dedicate ourselves anew to making it possible for those who are gifted in art, science and religion to approach the unknown with true reverence, and not under the compulsion of producing immediate results for the glorification of one man, one group, one race or one nation.

Are we as scientists doing all we can to make democracy succeed? Are we using our science vigorously and impartially, to bring greatly increased health, wealth, security and education to all the people of the United States? The fate of democracy and of scientific freedom will depend less on what we may say than on how unreservedly we dedicate ourselves to these deeds.

OBITUARY

THOMAS WINGATE TODD

January 15, 1885—December 28, 1938

IN 1937 there appeared a volume which expressed its purpose "to promote the welfare of the child in the interest of the Nation to the end that physical and mental health, in their fullness, may be added to the ideals of Loyalty, Honor and Service." The book so dedicated, the first of a series, was the "Atlas of Skeletal Maturation (Hand)," by T. Wingate Todd and his associates. In inscription the volume epitomized goal, and in content exemplified a scientific approach. It marked a milestone in bringing human anatomy from the study of charnel house material to the study of the living population.

Trained in the Hunterian tradition that an anatomist must know vertebrate and mammalian as well as human morphology, Dr. Todd was grounded in the comparative approach. To this was added the Egyptology of Sir Grafton Eliott Smith and the human paleontology of Sir Arthur Keith. With this background Dr. Todd built at Western Reserve University a laboratory of anatomy unique in the world: 3,000 skulls and skeletons of the Mammalia; 600 skulls and skeletons of anthropoids; 3,300 human skulls and skeletons, for each of which sex, age and stock (race) was known, and for each of which literally hundreds of anthropometric measurements were available. It was from this comparative and human material that Dr. Todd drew for his many contributions.

Physical anthropology owes to him the insistence that the study of man's body be based on carefully documented material and that it must turn from static problems of evolutionary stage to the dynamic march of unfolding pattern. From the skeletal material he learned those age criteria later to be applied to growth studies: appearance of centers of ossification, calcification of the teeth, union of epiphyses, age-changes in the pubic symphysis and on the articular ends of long bones, suture-closure and age-changes in vascularity and texture, particularly of the flat bones of the skeleton. The measurement of the human body was clarified by his studies of the reliability of locating bony landmarks as related to subcutaneous tissue thickness. He made possible a more accurate transition from craniometry to cephalometry, from osteometry to somatometry: measurement of the dead was for him valid only in so far as it contributed to a more precise measurement of the living.

Human anatomy was to Dr. Todd *living anatomy*. In pursuance of this theme he taught his first- and

second-year students gastric function and joint movement via fluoroscopy. A number of papers on the gastro-intestinal tract were published over a period of years. As a distinctly anatomical contribution Dr. Todd edited the chapter on the respiratory system in "Cunningham's Anatomy." At the time of his death he was preparing a volume on clinical anatomy.

With the establishment of the Brush Foundation, in 1928, Dr. Todd, as chairman, began an intensive and extensive study of growth in children. He was concerned not only with the anthropometry of growth, but with maturation—not alone growing, but growing *up* was the theme of his study. Thus it was that his research program embraced the range of physical and psychological investigation: progress in physical maturity and the analysis of increase in size and change in proportion; gain in weight and its relation to the maturation pattern; dento-facial development; brain potentials and muscle action currents; psychomotor development and the unfolding skills; steadiness, dexterity and eye-hand coordination; mental expansion and intellectual and social adjustment; interests, talents and vocational aptitudes; the development of emotional stability and personality traits. Reports treating of these many phases may be found in the Conference on Physical and Mental Growth in the Adolescent, Cleveland, 1930; Part II of the White House Conference on Growth and Development of the Child, 1933; "Atlas of Skeletal Maturation," 1937; and numerous shorter publications.

In recognition of his multifarious interests Dr. Todd served American science in many capacities: associate editor, *American Journal of Physical Anthropology, Child Development, Growth;* vice-president, American Association of Anatomists, 1920–21, 1938–39; vice-president and chairman of Section H, American Association for the Advancement of Science, 1922, 1933; president, American Association of Physical Anthropologists, 1938–39; member, White House Conference on Child Growth and Development, 1929–31. He was honored by membership in the leading anatomical and anthropological societies in the United States, as well as in honorary and scientific fraternities; he held membership in the Société d'Anthropologie de Paris, the Académie Royale de Médecine, Belgium, the Royal Anthropological Institute of Great Britain and the Zoological Society of London. As a civic leader in Cleveland he maintained active membership in many organizations for the promotion of community culture and welfare.

On December 15, 1937, Dr. Todd celebrated his silver anniversary as Henry Willson Payne professor of anatomy at Western Reserve University. It was destined that only one more year was to be added to this quarter-century of achievement, but so productive was he that to him scarcely applied the lines of Keats: "When I have fears that I shall cease to be ere my pen has plucked my teeming brain." Over 250 publications attest to his industry. He was a clear, forceful writer, given to almost lyrical passages; he wrote so that without sacrifice of scientific accuracy he might explain and interpret to the layman. His public addresses were punctuated with humor and adorned with apt phraseology. Seldom have scientist and layman enjoyed a more complete meeting of minds.

American anatomy and physical anthropology have lost a dynamic and far-thinking leader, but they have gained a vision of *living* man as the proper study of man. Generations to come will have life more abundantly for his work. Those of us who knew him and loved him have lost a teacher, colleague and friend.

WILTON MARION KROGMAN
UNIVERSITY OF CHICAGO

RECENT DEATHS AND MEMORIALS

DR. J. PLAYFAIR MCMURRICH, professor emeritus of anatomy at the University of Toronto, died on February 9 at the age of seventy-nine years.

DR. WILLIAM C. KENDALL, who retired in 1932 as aquatic biologist in the laboratory of the U. S. Bureau of Fisheries, died on January 28 at the age of seventy-eight years.

DR. CHESTER DALE CHRISTIE, assistant professor of chemical medicine at Western Reserve University, died on January 27 at the age of fifty-two years.

DR. A. W. PORTER, since 1928 emeritus professor of physics in the University of London, died on January 11. He was a founder member of the Faraday Society and was president of the society from 1920 to 1922.

DR. CHARLES JOSEPH GAHAN, from 1913 to 1927 keeper of the department of entomology of the British Museum (Natural History), died on January 21. He was seventy-seven years old.

PROFESSOR HENRY BALFOUR, curator since 1891 of Pitt Rivers Museum of the University of Oxford, died on February 9 at the age of seventy-five years. Dr. Balfour was a former president of the Royal Geographical Society. He had been a member of the Council of the Anthropological Institute of Great Britain since 1891 and was president of the institute in 1903–04. In 1904 and again in 1929 Dr. Balfour was president of the anthropological section of the British Association for the Advancement of Science.

DR. H. H. WOOLLARD, professor of anatomy in University College, London, died on January 18 at the age of forty-nine years.

THE ninety-second birthday on February 11 of Thomas Alva Edison was observed at the Franklin Institute, Philadelphia, by the opening of several spe-

cial exhibits, and the attention of visitors was called to permanent exhibits in various sections of the museum connected with Edison's life and work.

THE bi-centenary of the birth of William Herschel, who is called "the father of modern sidereal astronomy," was celebrated in London in January by the Royal Astronomical Society, of which he became the first president in 1820. At that time he was eighty-two years old.

THE Draper Chemical Society of New York University will mark the one hundredth anniversary of the appointment of John William Draper to the chair of chemistry and the chair of physics at New York University by a meeting and exhibit in the Nichols Chemistry Laboratory at University Heights on Tuesday evening, February 21, at eight o'clock. The following addresses will be presented: Professor William West on "The Scientific Accomplishments of John W. Draper," Professor Philip B. McDonald on "The Life of John W. Draper" and Miss Antonia C. Maury on "Personal Recollections of My Grandfather, John William Draper, and of Draper's Family." Miss Maury is curator of the Draper House and Museum at Hastings-on-Hudson. Apparatus used by Draper in his experiments and lectures at New York University will be exhibited together with some of his books and notes, much of it through the courtesy of his granddaughter, Mrs. Dorothy Draper Nye.

IN honor of William Bartram's two hundredth anniversary on February 9, the Academy of Natural Sciences of Philadelphia placed in its library an exhibit of Bartram's books and drawings. Probably Bartram's best-known contribution was his journal, "Travels through North and South Carolina, Georgia and East and West Florida."

SCIENTIFIC EVENTS

SYMPOSIUM OF THE AMERICAN INSTITUTE OF PHYSICS ON TEMPERATURE AND ITS MEASUREMENT

A SYMPOSIUM on "Temperature and its Measurement in Science and Industry" will be held under the auspices of the American Institute of Physics (175 Fifth Avenue, New York, N. Y.) probably next autumn, the dates to be announced later. Consistent with the title, the symposium will cover broadly many fields, its primary purposes, according to present plans, being (1) to coordinate the treatment of the subject in the sciences and branches of engineering; (2) to review principles and bring up to date the record of recent work; (3) to accumulate contributions for a comprehensive text, to be published as soon as possible after the symposium is held; (4) to reveal the subject as an important branch of physics, and (5) to supply schools with the information required for the improvement of curricula. The institute confidently expects that a stimulating, valuable and unified program will be arranged, an aim which will require the help of many contributors.

A representative steering committee has been formed consisting of the chairman, C. O. Fairchild, director of research, C. J. Tagliabue Manufacturing Company; Dr. E. F. DuBois, medical director, Russell Sage Institute of Pathology, and professor of medicine, Cornell University Medical College; Dr. Gustav Egloff, director of research, Universal Oil Products Company; Dr. John Johnston, director of research, U. S. Steel Corporation; Dr. Walter G. Whitman, head, department of chemical engineering, Massachusetts Institute of Technology, and Dr. H. A. Barton, director, American Institute of Physics.

Those who are interested in taking part in this symposium should communicate with the institute at an early date, giving information regarding their field of work and the subject of the contribution they wish to make. Such contributions will be coordinated with the subjects of a group of invited papers and assignments and divisions made. Further information for contributors will be available shortly.

THE BALTIMORE MEETING OF THE AMERICAN CHEMICAL SOCIETY

THE ninety-seventh meeting of the American Chemical Society, under the presidency of Professor Charles A. Kraus, of Brown University, will meet in Baltimore from April 3 to 7. Dr. J. C. W. Frazer, Baker professor of chemistry in the Johns Hopkins University, has been appointed honorary chairman of the meeting, and Dr. John C. Krantz, Jr., professor of pharmacology in the Medical School of the University of Maryland, has been named general chairman. Fifteen symposia reporting advances in scientific research and in the application of chemistry to industry, medicine, agriculture, food, engineering and public health are planned.

Seventeen of the eighteen professional divisions of the society will hold sessions. Details of the program follow:

The Division of Agricultural and Food Chemistry will sponsor a symposium on the Federal Food, Drug and Cosmetic Act, in which the Divisions of Biological Chemistry and Medicinal Chemistry will cooperate. The Division of Medicinal Chemistry will direct a symposium on "Endocrines," in which general papers within the field of medicinal chemistry will be presented.

The Division of Petroleum Chemistry is arranging a symposium on "The Rôle of Catalysis in Petroleum Chem-

istry,'' under the chairmanship of Professor H. S. Taylor, of Princeton University. Professor Emeritus V. N. Ipatieff, of Northwestern University, will be the guest of honor at a dinner of the division on Tuesday, April 4. He will deliver an address on ''The History of Catalysis and Petroleum Chemistry.''

The Division of Biological Chemistry has scheduled a symposium on ''Vitamins,'' and the Division of Cellulose Chemistry, a symposium on ''American Cellulose in 1939.'' The Division of Industrial and Engineering Chemistry has arranged a symposium on ''Thermal Insulation,'' in which the Division of Petroleum Chemistry will join.

The Division of Chemical Education plans four sessions —one a joint symposium with the Division of Physical and Inorganic Chemistry on ''Theories and Teaching of Acids and Bases''; another devoted to a group of papers on chemical education in high schools; a third, for student papers; and, finally, a session for miscellaneous papers within the field of the division. Hundreds of teachers in the colleges, universities, secondary and elementary schools in the nation will take part.

The Division of Physical and Inorganic Chemistry will present a symposium on ''Fundamentals of Heterogeneous Catalysis,'' with Professor Taylor as chairman. ''The Application of Micro- and Semimicrochemistry to Industry'' will be the subject of a symposium of the Division of Microchemistry, with Dr. G. E. F. Lundell, of the National Bureau of Standards, as chairman.

The Division of the History of Chemistry announces two sessions, one of which, jointly with the Division of Medicinal Chemistry, will be devoted to a symposium on the ''History of Medicinal Chemistry in Baltimore.'' Dr. Henry E. Sigerist, director of the Institute of History of Medicine of the Johns Hopkins School of Medicine, will be a principal speaker. Professor Krantz will present a paper on ''The History of Pharmacology in Baltimore.''

The Division of Rubber Chemistry will feature a symposium on ''Synthetic Rubber and Elastic Polymers.'' Other symposia will include ''Industrial Utilization of Dairy Products'' and ''Colloids and Water and Waste Treatment.''

Six sessions will be held by the Division of Organic Chemistry, four by the Division of Paint and Varnish Chemistry, two by the Division of Sugar Chemistry and Technology, and two by the Division of Gas and Fuel Chemistry.

THE TORONTO MEETING OF THE FEDERATION OF AMERICAN SOCIETIES FOR EXPERIMENTAL BIOLOGY

THE Federation of American Societies for Experimental Biology will meet in Toronto from April 26 to 29. The Royal York Hotel will be the headquarters, and all scientific sessions, motion pictures and state demonstrations will be held in this hotel. The federation is formed by the union of the American Physiological Society, the American Society of Biological Chemists, the American Society for Pharmacology and Experimental Therapeutics and the American Society for Experimental Pathology.

Dr. Glenn E. Cullen, of the University of Cincinnati, will be chairman of the federation by virtue of his election at the recent Baltimore meeting as president of the American Society of Biological Chemists. Dr. Walter E. Garrey is president of the American Physiological Society; Dr. Arthur L. Tatum, of the University of Wisconsin, of the American Society for Pharmacology and Experimental Therapeutics, and Dr. C. Phillip Miller, of the University of Chicago, of the American Society for Experimental Pathology.

The scientific sessions will begin on Thursday morning, April 27. Wednesday will be available for visiting the University of Toronto and other points of interest. The American Institute of Nutrition will meet in the King Edward Hotel, about four blocks away, on this day. On Thursday evening at 9 o'clock the local committee will provide an informal smoker. The annual dinner will be held on Friday evening.

The American Physiological Society will hold two symposia, one on "Carbohydrate Metabolism" and the other on "The Synapse." A joint symposium will be held with the Biochemical Society on "The Red Blood Cells."

Members of the local committee are: Dr. V. E. Henderson, *chairman;* Dr. N. B. Taylor, *secretary;* Dr. E. T. Waters, *treasurer;* Dr. G. E. Hall, Dr. A. M. Wynne, Dr. D. Y. Solandt, Dr. G. H. Lucas, public information; Dr. R. A. Cleghorn, Dr. G. L. Duff, Dr. P. H. Greey, Dr. W. R. Campbell, Dr. J. K. W. Ferguson, Dr. D. A. Irwin, Dr. K. C. Fisher and B. F. Crocker.

THE SIXTH PACIFIC SCIENCE CONGRESS

ANNOUNCEMENT has been made by the National Research Council that the Sixth Pacific Science Congress will be held in San Francisco and vicinity during the period, July 24 to August 12, 1939, under the auspices of the council. The fifth congress in this series was held at Victoria and Vancouver, B. C., in 1933, under the auspices of the National Research Council of Canada, and previous congresses have been held at three-year intervals in other countries of the Pacific region.

Sessions of the sixth congress will be held at Stanford University and at the University of California at Berkeley, as host institutions on this occasion, and certain public functions and other sessions of the congress will be held in "Pacific House" on the grounds of the Golden Gate International Exposition through courtesy of the Department of the Pacific Area of the Exposition. The general arrangements are in charge of the standing Committee on Pacific Investigations of the National Research Council, of which Dr. Herbert E. Gregory, director emeritus of the Bishop Museum in Honolulu, is the chairman. Responsibility for completing the program and for local arrangements is in the hands of a Committee on the Sixth Pacific Science

Congress, especially appointed by the Research Council for this purpose, of which Dr. Charles B. Lipman, dean of the Graduate School of the University of California at Berkeley, is the chairman.

In accordance with the plans of previous congresses of this series, the program of the sixth congress will "emphasize the discussion of comprehensive scientific topics of general interest to the peoples living within the Pacific basin," and the theme of the congress will be "the present stage of knowledge of Pacific scientific problems and methods by which that knowledge may be most profitably enlarged." As the congress is designed for discussion and interchange of ideas rather than for precise formulation of attempted solution of problems, the program is being arranged as a series of symposia rather than as a list of independent papers. Among the subjects to be discussed are:

The Pacific Basin: structure and dynamics; geophysics and geology.

The Pacific Ocean: properties, dynamics and life; oceanography.

Pacific climates, past and present: meteorology, paleontology, paleobotany.

Man and culture in the Pacific region; characteristics, dispersal and development, objectives and results of research; anthropology, human geography and ethnobotany.

Territorial fauna of Pacific islands: characteristics, origin, distribution, human relations; chiefly entomology, malacology and ornithology.

Terrestrial flora of Pacific islands and border lands: characteristics, origin, distribution, human relations; botany.

Classification and utilization of Pacific lands.

Communicable diseases of the Pacific area: origin, history, distribution; tropical medicine.

Nutritional problems of the Pacific area.

Conservation of the marine life of the Pacific Ocean.

Soil resources of the Pacific islands and borders: characteristics, conservation.

Miscellaneous topics:

Facilities and program of institutions interested in scientific studies of the Pacific area.

Means and methods for cooperative research.

Present status of research in Pacific scientific problems and the outstanding problems that merit attention.

General lectures on regions and special topics.

Additional information concerning the congress may be obtained by addressing the secretary-general, Dr. Roy E. Clausen, Room 205 Hilgard Hall, University of California, Berkeley, California.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE AND THE NATIONAL EDUCATION ASSOCIATION

JUST before the meeting in Richmond, on December 24, the officers of the association received the following letter from Dr. Reuben T. Shaw, president of the National Education Association:

As a fellow of long standing in the American Association for the Advancement of Science, who is now honored with the leadership of the National Education Association, I extend to you the greetings of the nation's teachers and their best wishes for the success of your convention at Richmond.

Scientists and teachers have a community of interest. The scientist discovers truth, the teacher interprets it. We hope that both may cooperate as one profession, interested in aiding man on his road to happiness. In that capacity let us appraise the results of research and investigation, not so much in terms of scientific achievement as in terms of their effect upon the democratic society which the American people have adopted as the Good Life.

It is one thing to shout the alarm that democracy is challenged to-day. That alarm has often been sounded. It is another thing quietly to answer that challenge with the effective weapons that lie in truth and its acceptance and application by mankind. Those weapons are the tools with which the scientist and the teacher work each day. With them let us lay impregnable foundations for the security of free self-government.

By unanimous vote of the council on December 30, the officers of the association sent the following reply to Dr. Shaw:

The Council of the American Association for the Advancement of Science has received with lively appreciation the friendly greetings of the National Education Association which are conveyed in your letter of December 23. It is a source of satisfaction that two of the largest organizations of teachers and scientists in the world are affiliated and consciously cooperating in the increase and diffusion of knowledge among men. Many of the members of the American Association for the Advancement of Science are teachers, many of the National Education Association are scientists, and in large part the ultimate aims of our two associations are complementary.

With the belief that there can be no permanent progress of mankind except through the discovery and promulgation of truth and that science and education are now the principal means of human progress, the American Association for the Advancement of Science welcomes the cordial cooperation of the National Education Association and in turn desires to offer its support in your efforts to increase and improve education.

SCIENTIFIC NOTES AND NEWS

DR. WILLIAM D. COOLIDGE, director of the Research Laboratory of the General Electric Company, has been awarded the Faraday Medal for 1938 for "notable scientific and industrial achievement" by the council of the British Institution of Electrical Engineers. Dr. Coolidge is the second member of the General Electric Company to receive the medal, the other having been the late Dr. Elihu Thomson.

THE second annual award of the British Institute of Metals has been made to Sir Harold Carpenter, professor of metallurgy in the Royal School of Mines, London, and will be presented to him on March 8. The medal, which is of platinum, is the gift to the council of the institute of the Mond Nickel Company. The first award of the medal was made last year to Sir William Bragg.

THE Meuller Medal of the Science Congress, which opened in Canberra, New South Wales, on January 11, was awarded to Dr. T. H. Johnstor, professor of zoology at the University of Adelaide, in recognition of his "outstanding published scientific works."

DR. W. R. DODSON, professor of agronomy in the College of Agriculture of Louisiana State University, was tendered a testimonial dinner on February 2 by the section of animal husbandry of the Association of Southern Agricultural Workers. Dr. H. P. Cooper, president of the association, presided, and Professor J. B. Francioni, Jr., head of the department of animal husbandry at Louisiana State University, was toastmaster. The speakers included: Dr. J. G. Lee, Jr., dean of agriculture, Louisiana State University, and Dr. E. W. Sheets, of the Mississippi State College, chairman of the section of animal husbandry of the association.

THE National Museum of Natural History, Paris, has awarded to Dr. Howard S. Reed, professor of plant physiology at the College of Agriculture of the University of California, a diploma conferring the title of "Correspondant du Museum."

THE degree of doctor of science was conferred on Sir Arthur Stanley Eddington on the occasion of the installation of the Duke of Devonshire as chancellor of the University of Leeds.

IT is announced in *Nature* that Arthur Conway, professor of mathematical physics in University College, Dublin, has been appointed a member of the Pontifical Academy of Sciences to occupy the seat left vacant by the death of Lord Rutherford.

PROFESSOR ARTHUR FREDERICK BERNARD SHAW, who was recently elected to the professorship of pathology at the University of Durham, has been given authority to wear the insignia of Commander of the Order of the Nile, conferred upon him by the King of Egypt in recognition of services rendered by him as professor of pathology in the Egyptian University, Cairo.

WILLIAM ABBETT LEWIS, JR., engineer of the Westinghouse Electric and Manufacturing Company, in Pittsburgh, and a Westinghouse lecturer in electrical engineering at the University of Pittsburgh, has been appointed director of the School of Electrical Engineering of the College of Engineering, Cornell University. The title of emeritus has been conferred on Paul M. Lincoln, who retired in June from the directorship, a position that he had held since 1922. Dr. Lincoln continued as acting director of the school until the appointment of Dr. Lewis as his successor on February 1.

DR. CHARLES D. LUKE, who joined the faculty of the College of Applied Science of Syracuse University in September, 1937, has been appointed acting head of the department of chemical engineering, succeeding Dr. Lloyd Logan, who died in December.

PROFESSOR WALTER P. KELLEY, who has served at the Citrus Experiment Station of the University of California at Riverside since 1914 as professor of agricultural chemistry and professor of soil chemistry, has joined the faculty of the College of Agriculture at Berkeley in the latter capacity and as chemist in the Agricultural Experiment Station.

A BUREAU of Instructional Research has been established at the University of Nebraska, with Dr. J. P. Guilford, professor of psychology, as director. He will continue to devote part of his time to teaching. H. M. Cox, of the University of Georgia, has been appointed to full-time work in the bureau.

PROFESSOR G. R. GIRDLESTONE has tendered his resignation as Nuffield professor of orthopedic surgery at the University of Oxford.

C. C. L. GREGORY, lecturer in astronomy at University College, London, has been appointed director of the observatory.

DR. R. L. SMITH-ROSE has been appointed superintendent of the Radio Department of the British National Physical Laboratory, which includes the Radio Research Station at Slough in addition to the section of the department at Teddington. Dr. Smith-Rose since 1936 has been principal scientific officer-in-charge of the departments.

AT the Long Island College of Medicine, Dr. Cassius Hinds Watson, medical director of the American Telephone and Telegraph Company, has been elected a member of the board of trustees. A graduate of the class of 1905, he succeeds the late Dr. Frederick Tilney, of the class of 1903, as alumni trustee. Health Officer Fred L. Moore has become associate professor in the department of preventive medicine and community health. The development of the work of the department has been made possible by a grant of $43,750 from the Commonwealth Fund.

DR. JAMES K. WILSON, professor of agronomy at Cornell University, who has spent three months making a collection of leguminous plants and of soil bacteria in the West and South, has returned to Ithaca.

J. FRANCIS MACBRIDE, associate curator of the her-

barium of the Field Museum, Chicago, who has been in Europe since 1929 obtaining photographs of type specimens of plants in herbaria of various countries, has returned to his headquarters at the Paris Jardin des Plantes, after several months of work in Geneva and Florence. The museum recently received from him about 1,500 additional negatives, bringing the total number in the collection to 36,000. Prints from these are made available at cost to botanists and institutions all over the world.

DR. C. L. TURNER, of the department of zoology of Northwestern University, has leave of absence for the second semester of this year. He will continue his research on viviparous fishes in Mexico.

DR. H. W. NORRIS, of Grinnell College, is spending a few months at the Bass Biological Laboratory in Englewood, Fla. He is engaged in further work on the pituitary bodies of sharks and rays. Dr. Madelene Pierce, of Vassar College, expects to spend some weeks at the laboratory, where she will undertake ecological studies of the local fauna.

DR. HERBERT H. WHETZEL, professor of plant pathology at Cornell University, sailed on February 10 for Venezuela, where he plans to stay for two months continuing the plant disease and mycological survey of the American tropics. He goes as a collaborator of the U. S. Department of Agriculture, in cooperation with the Venezuelan Department of Agriculture. He will collect fungi and diseased plants to add to the collection of the department. Dr. Carlos E. Chardon, formerly president of the University of Puerto Rico and now in charge of cotton production at Maracay, and Albert S. Muller, plant pathologist at the government agricultural experiment station at Caracas, will take part in the work.

DR. T. LYNN SMITH, head of the department of sociology of the Louisiana State University, has been granted leave of absence for the 1939 summer session to conduct a social and economic survey of Central and South American countries. His survey will be in furtherance of the program initiated last summer for the promotion of greater cooperation between the Americas. A school of Pan-American agriculture, to operate as a unit of the College of Agriculture of the Louisiana State University, is now in progress of organization and, it is expected, will be opened with the 1939–40 session. Representatives of Central and South American governments are cooperating in the organization of the school. A conference with representatives of the U. S. Department of Agriculture is to be held at the university within a few weeks.

PROFESSOR HARRY S. SMITH, head of the division of beneficial insect investigations of the Citrus Experiment Station of the University of California at Riverside, has left for Europe to find parasites of insect pests of the deciduous fruits of California. He plans to visit the Universities of Cambridge and Oxford and the Farnham Royal Laboratory of the Imperial Institute of Entomology, London; the Laboratories of the French Ministry of Agriculture, and the Royal School of Agriculture at Portici, Italy. It is expected that his search will be conducted primarily in France, Italy, Switzerland, Yugoslavia, Hungary, Czecho-Slovakia and south Germany.

DR. HENRY E. SIGERIST, William H. Welch professor and director of the Institute of the History of Medicine at the Johns Hopkins University, has been appointed to the South African visiting lectureship for 1939. He will speak at the chief universities of the Union throughout August, September and October and will gather material there and in Egypt for his four-volume history of medicine. He will return in December.

DR. JACOB MARSCHAK, director of the Statistical Institute of the University of Oxford, spoke at Iowa State College on January 26 on "The Concept of Liquidity" and on January 27 on "Statistical and Economic Research." Dr. Claude E. ZoBell, of the Scripps Institution of Oceanography, La Jolla, Calif., at present visiting professor of marine microbiology in the College of Agriculture, University of Wisconsin, lectured at the college on January 20 on "The Other Two-thirds of the Earth." He gave a second lecture, under the auspices of Sigma Xi, on "The World Below Sea Level."

A JOINT meeting of the American Philosophical Society and the Franklin Institute is being held in Philadelphia on February 16 and 17. The first day of the meeting at the Franklin Institute was devoted to the commemoration of the life and work of Elihu Thomson. It was held under the auspices of the society and the institute, of the Central High School of Philadelphia, of the Massachusetts Institute of Technology and of the General Electric Company. Among the speakers announced for the afternoon were: Dr. Vannevar Bush, Dr. William D. Coolidge and Dr. Dugald C. Jackson, and in the evening John L. Haney, president of the Central High School, Philadelphia; Roland S. Morris, president of the society, and Dr. Karl T. Compton, president of the Massachusetts Institute of Technology. A film was exhibited showing Professor Thomson in conversation with the late president of the General Electric Company, E. W. Rice, Jr., and there was an exhibition of apparatus invented by Professor Thomson. A symposium on "Progress in Astrophysics" in the Hall of the American Philosophical Society was planned for February 17, the morning session to

be presided over by Dr. Harlow Shapley, director of the Harvard College Observatory, and the afternoon session by Dr. W. F. G. Swann, director of the Bartol Foundation of the Franklin Institute. In the evening there will be a lecture by Dr. Henry Norris Russell, professor of astronomy and director of the Princeton University Observatory, on "Stellar Energy and the Evolution of Atoms," at which Roland S. Morris, president of the society, will preside.

THE tenth annual meeting of the American Association of Physical Anthropologists will be held on April 4 and 5 at the Wistar Institute of Anatomy and Biology, Philadelphia.

THE Southeastern Section of the American Physical Society will hold its annual meeting at the University of Georgia, at Athens, on March 31 and April 1. A symposium on biophysics will be a feature of the program at which Dr. Detlev W. Bronk, director of the Eldridge Reeves Johnson Foundation for Medical Physics at the University of Pennsylvania, will be a guest speaker.

THE Midwestern Psychological Association will hold its annual meeting at the University of Nebraska on May 5 and 6, under the presidency of Dr. E. S. Conklin of Indiana University. The title of Dr. Conklin's presidential address will be "The Status of Academic Psychology." A special feature of the meeting will be the commemoration of the fiftieth anniversary of the founding of the psychological laboratory at the University of Nebraska, by Harry Kirke Wolfe.

THE 1938 expedition of the American School of Prehistoric Research was limited to certain parts of Anatolia and Bulgaria. Dr. Dorothy A. E. Garrod, of Cambridge University, the well-known authority on the prehistory of the Near East and leader of the expedition, was assisted by James H. Gaul and Bruce Howe, both former students of the school and at present enrolled in the Graduate School of Harvard University. In the cave of Batcho Kiro, near Drenovo, Bulgaria, they found a stratified paleolithic sequence (Mousterian and Aurignacian), surrounded by a deposit containing pottery and a recent fauna—the first sequence of this kind to have been reported from Bulgaria. With permission of the government and supervision by the National Museum in Sofia, the school will, in the near future, continue the excavations so auspiciously begun at Batcho Kiro.

THE Standards Association of Australia has established a Chemical Industry Committee, the functions of which are coordination and supervision of preparation of standards of chemical analysis and sampling therefor, and standards for materials and products the manufacture of which may be regarded as coming substantially under the heading "Chemical Industry." It will also act as an Advisory Committee to the Council of the Association on all matters relating to chemical industry. The committee consists of representatives of the Australian Chemical Institute, the Australasian Institute of Mining and Metallurgy, educational and government departments and other organizations with chemical interests. Dr. H. B. Taylor has been appointed chairman.

THE Rockefeller Foundation has offered to the University of Oxford £600 for the year 1939 to provide in the department of pharmacology scientific apparatus, laboratory supplies, technical assistance and a fund for current research expenses for investigation on hormones and on the central nervous system.

DISCUSSION

DESCARTES AND THE MODERN WORLD[1]

TO-DAY philosophers and scientists of the world do not hesitate to admit that in the mathematics lies the supreme creation of the human intellect. In every civilization of record the mathematician has occupied himself with the universe of number and of form, the creation of the mind. No external necessity and no practical need determined the developments of mathematical science. However, as developments were made applications were found, and thus, for example, the sciences of astronomy and physics were evolved, in truth, out of the mathematics.

For some thousands of years mathematical science could record a conquest of the material universe in the laws of number and of form largely only upon the assumption of a reasonable universe. Day follows upon day, season upon season, eclipse upon eclipse, in a determinable order; for many centuries the elementary arithmetic and the algebra with the pure geometry of the conics, the circle and straight line were sufficient for such physical measurements as the physicists and astronomers could achieve.

With Viète, Descartes and Fermat, and Leibniz and Newton a wholly new era of mathematics enters into the panorama of intellectual history. In this period the mathematical achievements of the ages are crystallized into systems that give control over the material universe far beyond simple explanation of known phenomena.

Permit an apparent digression, for a moment, to insist that the veritable proof of science lies not simply

[1] A paper presented in Paris, in July, 1937, at the Third International Congress of Philosophy and the Descartes Tercentenary; the author was one of the official delegates of the United States, appointed by President Roosevelt.

in the mathematical explanation of known phenomena nor even in the construction of machines. The incontestable proof of reason, the veritable demonstration of science lies in prophetic assertion concerning hitherto unobserved phenomena which lie beyond the control of the prophet scientist.

Two illustrations must suffice, since the power of the mathematical formulation to explain observed effects to suggest to the competent observer new and unobserved physical phenomena or the creation of new devices in the given field has been repeatedly demonstrated. With Adams and Leverrier you have the proof positive of the adequacy, for that day, of the Newtonian theories in the prophetical mathematical creation of the planet Neptune. The Newtonian laws justified the observed path of the moon, with the exception of certain perturbations. These variations, not consistent with the observed phenomena, could be explained by the postulation of the existence of another planet with an orbit that was derivable from the mathematical equations.

As a second illustration, D'Alembert, using the methods and notations furnished by Viète, Descartes, Newton and Leibniz and others, was able to set up the differential equations which explain the observed phenomena of wave motion. In the hands and mind of Maxwell this led to the electromagnetic theory of light and to Maxwell's prophecy concerning, in common language, "wireless electric waves." It is in the formulas of Maxwell that the radio is prophesied and one may say constructed. Hertz then found the coherer and thus actually detected the rays prophetically constructed by Maxwell; this was equally, as Hertz himself explicitly indicated, the achievement of Maxwell, an unhoped-for gift given by the mathematical formulation. The undeniable proofs of the correctness of Maxwell's equations are furnished finally by the senses in the phenomena whose existence is revealed as a by-product.

It is with some hesitation that I suggest to my philosophical colleagues that mayhap the answer to the ever-recurring question "What is reason?" lies most often in the demonstrations in the world of physical phenomena and must, in some measure, rest upon the material.

The modern mathematics of Viète, Descartes and Newton and the control over the physical universe was made possible by the logical geometry of the Greeks, the arithmetic, the algebra and the trigonometry of the Hindus and the Arabic genius for exposition and combination and extension of the Greek and Hindu material. Particularly the trigonometry to which the Arabs made many independent contributions was essential for the subsequent control over the physical universe.

To-day one can say, without hesitation, that in these developments that were transmitted to Europe by the Arabs the mathematical science of Egypt and Babylon contributed no mean and insignificant part.

The transmission to Europe of the science of the Orient and the near East was effected over several centuries by Latin and Hebrew translations. The universities were created to a large extent, as Sarton has indicated, to make possible the systematization of the tremendous mass of scientific material revealed to Europe in the translations.

Italy played a most important role in the development of algebraic techniques and notably in the algebraic solution of the cubic and bi-quadratic. In an attempt to systematize these solutions Viète created the literal symbolism, the initial and crucial step towards a new mathematics.

Without Viète there could be no Descartes and Fermat; without Viète, Descartes and Fermat, there could be no Newton and Leibniz.

Recall that the symbolism of Newton is a variation of Viète's literal symbolism employing the fluxion overhead dot; the Leibniz $\frac{dy}{dx}$ is another variation of the Viète literal symbolism. To the philosopher the paradoxes and the difficulties of the infinitesimal and the infinite cause a great deal of trouble; witness the papers of this congress. For philosopher and mathematician no solution is possible without some mathematical symbolism. For the application of mathematics to physical problems the infinitesimal calculus with some adequate notation is the only known road.

What is the part of Descartes in the progress of the mathematical control of the universe? In truth one can say that the analytical geometry is the application of the literal symbolism to geometry, the necessary first step towards the application of algebraic methods to physical phenomena.

Descartes' use of Viète's symbolism revealed that the literal symbolism (of x, y and r or v) was equally powerful in trigonometry. Upon this followed also, as Professor Elie Cartan, of Paris, has so well shown, the introduction into geometry of imaginary elements. The literal symbolism in the real plane made the $x + i.y$ symbolism of the complex plane an inevitable continuation. The interplay here between the algebra of real quantities, the algebra of complex numbers and the geometry and the trigonometry made possible mathematical developments of the greatest importance for the domination of the physical universe.

The fundamental importance of trigonometry in the progress of mathematical science has not been sufficiently recognized by historians of mathematics. To apply the mathematics to physical phenomena it was absolutely essential to have mathematical expressions

for recurrence. The Hindus, by a stroke of genius, dropped the Greek trigonometry of chords and introduced the half-chord or sine function. With the shadow function of the Hindus, further developed by the Arabs and Europeans, one has a trigonometry adaptable to simple mathematical formulations, as Viète demonstrated in so masterly a fashion. This trigonometry leads back again to algebraic formulations employing the complex numbers; it is sufficient here to mention the names of Demoivre and Euler and Gauss. Progress in early mathematical science hinged upon this constant interplay between algebra and geometry. This was the path, also, that made possible the application to physical phenomena. It is for that reason that one can say that Viète, Descartes and Fermat, Newton and Leibniz created the modern world in which recurrent phenomena, not only the wave motion of the mathematician, but also "quantity production" made possible in industry by such phenomena, play so important a role.

In conclusion I must recur to a point of view mentioned by Professor Elie Cartan, *i.e.*, that there are those who deny to Descartes the invention of the analytic geometry. The opinion of Coolidge,[2] that the Greeks invented analytic geometry, is characterized, possibly by a slip of the pen, as "une des opinions les moins déraisonables."[3] I prefer to phrase it as "les plus déraisonables." This assertion by Coolidge is an absolute denial of progress in science. This is, it seems to me, of a piece with that madness that would characterize all science as Greek or as Aryan. If you say that the Greeks had the analytic geometry, what becomes of all that majestic work done by the Hindus, systematized and transmitted by the Arabs, and worked over again by generations of Europeans, culminating in Viète, Descartes and Newton. Science is progressive; mathematical science is the indisputable achievement of the human intellect of all the ages past and of all peoples, including Moslems and Jews and Christians and followers of other gods.

The modern world of electricity, of the aeroplane, of quantity production and of the wireless was made possible by the mathematical formulas of the literal algebra, the analytical geometry, the trigonometry and the calculus with their derivative sciences. The new mathematics made it possible not only to explain the observed phenomena but to create a new material world quite different from the old world. In the process of transition many have forgotten and some would even deny the mathematical creation. The progressive character of this creation has made it easy to forget the creator.

In mathematics one can not leap from the Greeks to Newton and Leibniz. There is only one intellectual highway to the modern mathematics and that leads, as I have indicated above, through the intellectual accomplishments of the Hindus and Arabs, by the way of the Jewish and Christian translators of the Arabic and the Greek, through Europe of the middle ages and the renaissance to those majestic men of science, Viète, Descartes and Newton. Their work crystallized the mathematical achievements of all past ages; no nation can claim them; in any age of reason these men belong to humanity.[4]

LOUIS C. KARPINSKI

[2] See J. L. Coolidge, *Osiris*, I, pp. 231–250, 1936.

[3] Elie Cartan, *Actualités scientifiques et industrielles*, 535: 146–153, 1937.

AUTHORITY CITATIONS IN NOMENCLATURE

THE discussion of authority citations raised by Donald Culross Peattie and continued by others seems, thus far, to have been confined to workers in modern biology. The problem is even more acute in the fields of paleontology and paleobotany where species are often necessarily established on form rather than on phylogenetic bases, as well as on fragmentary remains. Later evidence may require one or more subsequent changes to be made in the classification of a species, in which case a full citation of authorities becomes impossible.

A case in point is that of the Carboniferous fossil fern originally called *Staphylopteris sagittatus* Lesquereux, described and figured in the Report of the Geological Survey of Illinois, Volume IV, 1870. Ten years later Lesquereux himself had cause to refer this species to a new genus, and the change was published in the Report of the Second Geological Survey of Pennsylvania, Vol. 1, 1880. To be actually complete, the name and authority would have to be cited as *Sorocladus* (*Staphylopteris*) *sagittatus* (Lesquereux) Lesquereux. A further study of the species was next made in 1902 by Sellards, working in Kansas, who found that the species should be referred to the genus *Crossotheca* Zeiller. This change was published in the *American Journal of Science*, Vol. IV, 1902. Obviously, a complete citation of authorities after the name would be awkward. Consequently, the name is usually cited by paleobotanists merely as *Crossotheca sagittata* Lesquereux, credit being given to the original author without reference to the several authors of the generic changes. Examples of this nature are numerous, and it can be seen at once that a change in authority with every change in classification would lead to disassociation of a given species from its original description. This would lead to endless confusion, especially among younger workers in the field who have not had

[4] See also: B. de Kerékjártó, *Actualités scientifiques industrielles*, 535: 166–173; Casimir Wize, the same, pp. 144–146; M. Abel Rey, the same, 531: 27–32.

the opportunity of becoming thoroughly acquainted with the ever-increasing literature in the respective fields.

The greatest burden to the research worker is the necessity of tracing a species through the maze of national, local and foreign literature bearing upon a particular subject. Only at very large institutions is most of this literature available for use. The worker in smaller institutions or remote localities is handicapped by not having thousands of publications readily accessible to him. A step toward the solution of the problem was made by David White, who maintained a private catalogue of paleobotanical nomenclature covering the Paleozoic Era during his lifetime. The work was never published; however, specialized catalogues of similar natures have been published by various authors in the past, but these soon become out of date. The time and cost of such work does not allow for private revision as often as desirable.

It seems that the establishment of a national or international bureau of registration for nomenclature of biological and paleontological names is necessary for the satisfactory conclusion of the problem. When once established, it should be made mandatory for every author to register at this bureau his new species or generic changes, together with references to the publications in which they appear. Failure to register would invalidate the work. In this way, authors could continue to publish their works in various well-known or obscure publications, as at present, but all references to such works would become readily available to other workers by reference to the central bureau acting as a "clearing house." Workers in remote localities, where vast amounts of literature are not available, could obtain pertinent references by application to the bureau; and on the other hand, work which they accomplish would become recognized elsewhere immediately upon publication. Needless to say, countless hours of work would be saved the research worker who, under present conditions, must spend the greater part of his time tracking down references.

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POLYCHAETE ANNELID WORMS IN THE GREAT LAKES

A NUMBER of years ago, O. L. Meehean[1] reported finding a minute (2.9 mm), transparent polychaete annelid worm in Duluth Harbor. In the summer of 1936 I found a single specimen of what is very probably the same worm in Lake Erie at a depth of 55 feet, in the open lake approximately 30 miles due east of Put-in-Bay, and during this past summer I obtained additional specimens from the same locality. Since these worms have been found in both Lake Superior and Lake Erie, it is highly probable that they are quite generally distributed throughout the Great Lakes. Needless to say, the occurrence of a polychaete annelid in these lakes is a matter of interest, since the Polychaeta compose an almost exclusively marine group, of which very few species have been reported from North American fresh waters. In 1858, Leidy[2] described a sabellid polychaete from the Schuylkill River at Philadelphia, which he named *Manayunkia speciosa*. Later, with additional specimens from Egg Harbor River, N. J., he gave a more complete description. Early in the present century, Johnson[3] described nereids from California, and more recently Olga Hartman[4] has added others from the same region.

Comparison of my Lake Erie polychaetes with Meehean's description of his Lake Superior specimens leads me to think the worms are the same, an opinion with which Meehean agreed in conversation. He had previously referred his specimens tentatively and with some doubt to Leidy's species. The Lake Erie worms agree sufficiently with Leidy's description and figures to warrant placing them in the genus *Manayunkia*, but they differ so sharply in certain important features that it appears very doubtful whether they belong to the species Leidy described. For instance, he mentions and figures a pair of haemal loops in each segment which do not occur in the specimens from the Great Lakes. At the anterior end of these latter specimens there is an open collar which surrounds the base of the tentacles. Leidy states that the border of the head "projects dorsally into a rounded process," but he makes no mention of an open collar. The arrangement of the tentacles also differs. Leidy describes a pair of lateral lophophores, each of which bears a double row of tentacles. In the Lake Erie specimens there is a pair of lateral lophophores on each side of the head, the tentacles of which are not arranged in two regular rows in the manner described and shown by Leidy.

Leidy's well-sustained reputation for accuracy in observation and description lends weight to the significance of the discrepancies between his description of *Manayunkia speciosa* and the conditions found in the specimens from the Great Lakes. In view of the discrepancies and pending a more detailed description which is being prepared, I propose to designate the worms from Lake Erie as *Manayunkia eriensis*.

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[1] O. Lloyd Meehean, SCIENCE, 70: 479, 1929.

[2] Jos. Leidy, *Proc. Phila. Acad. Nat. Sci.*, 1858, 90; 1883, 204.

[3] H. P. Johnson, Mark Ann. Vol.: 205, 1903.

[4] Personal letter.

ELLIPTICAL ERYTHROCYTES

IN reply to the note of Terry[1] regarding the erythrocytes of the "sloth," the description by Gulliver[2] apparently need not be questioned. Examination of red blood cells in sections of various organs of several species of Edentata (*Cholopus didactylus,* the two-toed sloth, *Bradypus tridactylus,* the three-toed sloth, anteaters and armadillos) and of other types of mammals including four species of Camelidae, as well as many species of birds, shows that the morphology of these cells is sufficiently characteristic to prevent confusion. The erythrocytes of the sloths are, as in mammals generally, circular, bi-concave discs, while those of Camelidae are oval and convex. Incidentally, Gulliver[2] noted that the erythrocytes of llamas have a greater length-width ratio than those of camels, that, in certain Cervidae, these cells often are very irregular in shape, and that, in Edentata, they are among the largest found in mammals. This author also was aware that characteristic shape of red blood cells might be altered by disease. In captivity, the sloth usually is not a hardy animal. Perhaps Schartum-Hansen[3] encountered a description of blood cells from a diseased animal, although he does not give references.

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SCIENTIFIC BOOKS

TEXT-BOOKS IN PHYSICS

Physik. PAUL WESSEL. Pp. xii + 504. Reinhardt, München, 1938. RM 4.90.

College Physics. HENRY A. PERKINS. Pp. ix + 820. Prentice Hall, 1938. $3.75.

The Elements of Physics. ALPHEUS W. SMITH. Pp. xix + 790. McGraw-Hill, 1938. $3.75.

An Outline of Physics. ALBERT E. CASWELL. Pp. ix + 590. Macmillan, 1938. $3.75.

Glossary of Physics. LEROY D. WELD. Pp. vi + 255. McGraw-Hill, 1937. $2.50.

Physics for Technical Students. 2 Vols. W. B. ANDERSON. Pp. vii + 795. McGraw-Hill 1937.

Sound Waves and Acoustics. M. Y. COLBY. Pp. ix + 356. Henry Holt, 1938. $2.80.

Experimental Physics, A Laboratory Manual. S. W. WILLIAMS. Pp. 158. Ginn and Co., 1937. $1.00.

A First Course in Physics for Colleges. MILLIKAN, GALE and EDWARDS. vii + 712 + lxii, 1938. $4.00.

Introduction to College Physics. C. M. KILBY. Pp. x + 398. Van Nostrand. 1938. $3.25.

Elementary Practical Physics. BLACK and DAVIS. Pp. ix + 710. Macmillan, 1938. $2.00.

Physics of To-day. CLARK, GORTON and SEARS. Pp. vi + 633. Houghton, Mifflin, 1938. $1.80.

THE teaching of physics depends on three factors, the teacher, the laboratory equipment, the text-book. The teacher, master of his subject and of the techniques connected with it, given a reasonable appropriation, will see to it that the laboratory equipment is ample. He may find any one of several texts satisfactory; even a condensed syllabus may serve his purpose. Clear in voice, logical in arrangement, with experimental demonstration at his finger tips, masterful in presentation, he should be the inspiring factor. But a good text-book would help.

The text-books listed above are arranged more or less in order of the domain of general physics which they cover, not in order of the number of pages. The German text presents the entire subject, as we understand it in this review, in 354 pages (9 × 16 cm). Then to condense it still further it is gathered into 60 pages in a "kurtzes Repetitorium and Formelsammlung." This is followed by 60 pages of tests "Prufungsfragen und Antworten." It is similar to a catechism. A question is asked, the page on which the answer can be found is given. "Wie lauted das Daltonsche Gesetz? (S55)." "Was verstehl man unter Verdunstungkälte? (S87)." "Welches sind die Grundedanken der Quantheorie? (S348)." There are 1,447 such questions and answers. It is seen that these are non-computational questions. Numerical and algebraical illustrations are given in the body of the text. Finally, there are 40 pages of physical tables making the text a veritable handbook. Every artifice is employed by means of changes of type, capitals, boldfaced type, italics and by graphs of all kinds to emphasize and explain.

The next two texts are of the same order of completeness as the German text, but after the American manner of college texts in general physics. Professor Perkins's text is a first edition. A student will look at its 820 pages (10.5 × 17 cm) with apprehension. Can he master its contents in one college year? Probably not. Yet some teachers will value it for its completeness, others will reject it as a text to be used in their classes for the same reason.

The author maintains a high level throughout the book, and its compilation represents an intensive labor long continued. The last chapters dealing with modern physics are up-to-date and are among the best in the book. At times the reviewer has the feeling that the presentation is didactic rather than being based on experimental evidence. At times an extremely important point receives scant treatment. Take, for example, the treatment of the law of gravitation. It is stated that "the gravitational attraction between two

[1] M. C. Terry, SCIENCE, 88: 475, 1938.
[2] George Gulliver, *Proc. Zool. Soc., London,* p. 474, 1875.
[3] H. Schartum-Hansen, *Acta Medica Scandinavica,* 86: 348, 1935.

bodies is proportional to the product of their masses and is inversely proportional to the square of the distance between them." As this statement stands "the distance between them" has no meaning, and the statement is incorrect. The law should have been stated thus: "Every particle of matter attracts every other particle. . . ." Then it could have been pointed out, though this should have preceded the statement of the law, that one of the great contributions made by Newton was in proving that under the law of the inverse square the combined action of all the infinite number of particles of a uniform sphere upon a particle outside of it is equal to that of the whole mass of the sphere at its center. Only then are we justified in saying that the distance of the moon from the earth is 60 times the distance of an apple from the earth. Kepler's laws based upon experimental evidence then should replace the myth of the apple. The law of universal gravitation for every particle would follow.

The text is amazingly free from blunders and errors, but there is one fallacy. It is a fallacy which appeared about ten years ago in a text on modern physics and which has been adopted by various authors since then. It concerns the proof that light exerts pressure. The reviewer called attention to this fallacy and other fallacies in texts on modern physics a few years ago.

There is no padding in these eight hundred and more pages. There is no full-page photograph of the *Queen Mary* with joyous passengers on the decks waving to friends on shore, of monkeys describing parabolas as they leap from bough to bough, of Miss America in a one-piece bathing suit looping the loop on a bicycle. Practically no space is given to useless arithmetical computations, useless because they are of eighth-grade difficulty. The wording is direct, concise, clear. That this text is longer than any other in English with which the reviewer is acquainted is due to the fact that it deals with more topics than any other text. But what will the physics text of fifty years hence be like?

Professor Smith's text is the fourth edition; the first edition appeared in 1923. It has been greatly extended, new material has been added, there has been a change of emphasis in the older topics. A new chapter, an excellent one, on nuclear physics has been added. Then the author, feeling that 740 pages are not enough, adds another chapter on modern astronomy. But though relatively obsolete material has been discarded to make way for the new, we still find the antique ideas about levers of the first, second and third class. It appears that some writer of a textbook in physics back in the ages when the subject was young, desiring to fill up his book and to display a high sense for organization, set forth the above classification, and it has been repeatedly followed since.

Arithmetical solutions of problems, sometimes of an extremely elementary character, appear on almost every page. A formula has just been derived, the arithmetical values are substituted in the formula, the problem is solved. The student is excused from exercising his brain or of visualizing the phenomenon. Physics becomes something that is in a book. Thus

Example—What force is necessary to give a mass of 10 lb. an acceleration of 3 ft. per second per second? Force in poundals = mass in pounds × acceleration in feet per second per second.

$$F = ma$$
$$= 10 \times 3 = 30 \text{ poundals.}$$

And what does the student know about 30 poundals? For many years the reviewer has ruled out that kind of solution. He has told his students that frequently a formula is used in order to conceal one's ignorance. Here is the solution that the reviewer would accept. "Ten pounds (grams or tons) force gives to 10 lbs. (grams or tons) mass an acceleration of 32 ft. per sec. per sec. (Definition of a pound (gram or ton) force). Hence an acceleration of only 3 ft. per sec. per sec. would require only 3/32 of ten lbs. (grams or tons) force." The student knows what the answer means. No formula is required, none should be used.

There are not only some 780 pages in Professor Smith's text, there are 784 figures, some of them in two or three sections; there are also 9 full-page plates, some of them in color. This illustrates the great importance of visual aids in the teaching of physics. These visual aids supplement the classroom demonstrations of apparatus and of experiments; to these may be added moving pictures in slow motion. Text-book, teacher, student, all must emphasize the importance of an appeal to the eye. The great number of figures and plates in this text not only have a positive value as visual stories, they also have a value in making the text less terrifying to the student than it otherwise would be.

A physicist is probably an uncomfortable companion at any time. He may claim to know or want to find out cause and effect. But a physicist reviewing books may be looked upon as one in an excited state; and like an atom in that condition he is apt to emit a quantum of irritation upon seeing an error. In this case it is in "Fig. 267. Distribution of velocities." It should have been *speeds*. Hairsplitting? Not at all in this case. The curve for *velocities* is entirely different from that for *speeds*.

Professor Caswell's book is a second and greatly revised edition. The order of topics in the first edition (1928) was regarded as abnormal by many physicists. The new order is more nearly normal. The number of pages has been *reduced* from 773 to 590! This has been accomplished partly by omitting several topics in modern physics (only 40 pages as against 100) and

by limiting the topics in mechanics. There are no positrons or neutrons, there is no heavy hydrogen, no artificial transmutation or radioactivity, practically nothing about cosmic rays, no cyclotrons, in this text. With these exceedingly important items omitted one wonders why space should have been given to the theory of relativity.

The first thirty or forty pages of this text are in the form of a glossary—physical terms are defined or very briefly discussed, mass, temperature, force, electron, atomic numbers. Now a glossary similar to the next book in this list is a very satisfactory volume in the office of a journalist or even in a physics library, but no teacher would use it as a text-book. The reviewer believes that a physical term should be introduced only when the phenomenon involving the term is being demonstrated and studied. And here we note that the old picture of the atom is retained, the picture that was discarded in 1932 after the discovery of the neutron. Our new picture now presents the nucleus as composed of protons and neutrons, not protons and electrons (hydrogen one proton). The definition of atomic number is now the number of protons in the atom, not the number of electrons in the shells, we may take away an electron or neutron, but we can not take away a proton without changing the atomic number. It is not the energy of any one electron but the *maximum* energy of the electrons having a metal under the influence of light which depends only on the frequency of the light and the kind of metal.

In the body of the book the statements are clear, the illustrations numerous and apt, there are review questions and problems at the end of every chapter.

The glossary by Professor Weld began with a collection of definitions in card catalogue form kept in his office in Coe College. The Division of Physical Sciences of the National Research Council appointed an advisory committee to work with him to revise and, if necessary, extend this list, but its chairman, Professor Weld, has been the responsible compiler. Some 3,500 or 4,000 terms occurring in physics texts and periodicals are listed. Obviously this book would be an important volume in the library of a physics department. Many instructors in physics, journalists, science editors, will want to own one. But this reviewer seems hard to suit. Opening the book at random he reads a definition *"Fresnel rhomb*—A rhombic glass prism so shaped that a ray of plane-polarized light entering by one face emerges from the opposite face after two internal reflections and is thereby elliptically polarized." The Standard Dictionary says *circularly* polarized. But it may emerge plain, circularly or elliptically polarized. The original function of the rhomb was to produce circular polarization. Again at random the reviewer finds the definition of *photoelectric* not to his liking. The definition excludes the action of the so-called photronic cell, which is the outstanding photoelectric device of to-day. That cell is included under the term photovoltaic. The reviewer would make this term a subdivision of the former and would define "photoelectric effect—an effect due to the absorption of a quantum of radiant energy by an electron in such a way as to release the electron from its restraints, thus giving rise to a voltage or a current or a decrease of resistance." This would include *photovoltaic, photoelectronic, photoresistant.*

Professor Anderson's text is a third edition. It is only slightly more technical than the first two texts on this list. It is a little more concerned with engines of various sorts and devotes a total of only one page to several items of modern physics, neutrons, positrons, cosmic rays, transmutation of the elements.

The subject of sound has had a rebirth during recent years. By electrical means we are able to produce and to record sounds of any frequency and of any intensity. The telephone, microphone, sound film, public address system, are of great importance in human affairs. Professor Colby's book is written in recognition of this fact. Gently instructing the student in the mysteries of the sine curve, Newton's laws, ordinary mechanics, wave motion and other elementary matters, he proceeds to the discussion of the Rayleigh disc, phonometers, pressure microphone, piezo-electric oscillators, decibels and modern devices. Architectural acoustics as developed by Sabine, Watson and Knudson, auditory sensations and reactions as developed by Fletcher, Wente and other workers in the Bell Laboratories feature the closing chapters.

The Millikan-Gale-Edwards volume is a successor to various other texts by these or some of these authors. It is decidedly up-to-date. The frontispiece shows cloud tracks of positive and negative electrons from cosmic ray nuclear encounters and the last plate is labeled neutron tracks. (But neutrons leave no tracks! The authors should have labeled it—"Tracks of ions produced by neutron bombardment.")

This text contains 712 pages of type, about 600 diagrams and 94 full-page photographs or plates, "portraits of physicists and illustrations of recent achievements in physics." It is this last feature that distinguishes it from all the texts and makes it an exciting book. Do you want to see at a glance the progress of artificial lighting from the early torch to the modern incandescent lamp? Here is a full-page plate giving lamps and dates, the torch, pre-historic, stone lamp 3000 B.C., metal lamp A.D. 400, oil lamp 1600; 1879, Edison's first lamp 1.4 lumens per watt . . .; 1913, gas-filled lamp 20 lumens per watt. . . . The Hammond organ, air-conditioning Pullman cars, the world's largest telescope and mirror, the Rocket 4½ tons and

the Virginian Mallet 450 tons, side by side, lightning striking the Empire State Building. . . . There is perhaps a straining after "the world's greatest . . ." sometimes the student will learn no physics from the picture, but he will be interested and he may ask questions; certainly he will gain information.

Professor Kilby's book is a second edition (first, 1929). As the number of pages shows, it is a brief course in fundamentals. It is conservative and practical, orthodox and logical in its arrangement, direct and clear in statement, up-to-date in regard to neutrons, protons, electrons and atomic structure. It will answer the needs of many instructors giving a three-hour first course in physics.

Coming to high-school texts we have the book by the reminiscent combination, Black and Davis. Like the Millikan, Gale and Edwards text it has many figures (492), many photographs (116). As might be expected of these authors, the photographs are of up-to-the-minute affairs, the stratosphere balloon and gondola, radio meteorograph, electric refrigerator, rock-wool insulation, the cyclotron. Sometimes full use is not made of the photographs. Here is one of a tug of war between a 7,200-pound elephant and a tractor. But the weight of the latter was not given, nor the coefficient of friction in either case. Why not the draw-pull of each? (The tractor won.) The text is a study in pedagogy as well as in physics. It is inductive in method, emphasizes physical principles by illustrations from daily life, uses various styles of type to emphasize main points, qualitative questions and arithmetical problems follow each chapter, there are frequent summaries and reviews.

The Clark, Gorton, Sears text is very much like the Black and Davis, only more qualitative. Here again diagrams and photographs are much in evidence. There are 750 of these, together with several photographs of physicists. Some of the photographs of apparatus are out of the ordinary. Here are eight photographs which might be labeled "How to operate an airplane." Here are eight diagrams illustrating airplanes stunting—"A snap roll," "A chandelle," "An Immelman roll." There are several other photographs of airplanes. Obviously all these are for display or for arousing interest.

Again there is interest in the pedagogical aspect. There are previews of units, questions preceding every chapter to arouse the interest of the student, and at the end of each chapter exercises (qualitative questions and problems) and a summary.

The treatment everywhere is exceedingly elementary.

GORDON FERRIE HULL

SOCIETIES AND MEETINGS

THE AMERICAN CHEMICAL SOCIETY

ELECTION of 126 chemists to administrative and editorial posts in the American Chemical Society, which has a membership of more than 22,000, was announced recently. The society's eighteen professional divisions named officers for 1938–39, and editors of five scientific publications were chosen. The divisional officers are:

Division of Organic Chemistry: Chairman, Werner E. Bachmann, of the University of Michigan; *secretary,* Ralph L. Shriner, of the University of Illinois; *executive committee,* in addition to officers and ex-officers, Charles F. H. Allen, of the Eastman Kodak Company, Rochester, N. Y.; Louis F. Fieser, of Harvard University; Lyndon F. Small, of the University of Virginia.

Division of Physical and Inorganic Chemistry: Chairman, George Scatchard, of the Massachusetts Institute of Technology; *chairman-elect,* G. Frederick Smith, of the University of Illinois; *secretary-treasurer,* Harold C. Urey, of Columbia University; *on executive committee,* Harold S. Booth, of Western Reserve University; George S. Parks, of Stanford University.

Division of Industrial and Engineering Chemistry: Chairman, Walter L. Badger, of the Dow Chemical Company, Ann Arbor, Mich.; *vice-chairman,* Barnett F. Dodge, of Yale University; *secretary-treasurer,* Howard S. Gardner, of the University of Rochester; *executive committee,* Thomas H. Chilton, of E. I. du Pont de Nemours and Company, Wilmington, Del.; Donald B. Keyes, of the University of Illinois; Warren L. McCabe, of the Carnegie Institute of Technology; Walter A. Schmidt, president of the Western Precipitation Company, Los Angeles; Charles A. Thomas, president of the Thomas and Hochwalt Laboratories, Dayton, Ohio.

Division of Medicinal Chemistry: Chairman, Walter H. Hartung, of the University of Maryland; *vice-chairman,* Frederick Fenger, of Armour and Company, Chicago; *secretary,* Russell J. Fosbinder, of the Maltbie Chemical Company, Newark, N. J.; *on executive committee,* George D. Beal, Mellon Institute of Industrial Research, Pittsburgh.

Division of Biological Chemistry: Chairman, Joseph J. Pfiffner, of Parke, Davis and Company, Detroit; *secretary-treasurer,* G. O. Burr, of the University of Minnesota; *on executive committee,* Walter C. Russell, of the New Jersey Agricultural Experiment Station, New Brunswick, N. J.; Arthur H. Smith, of Wayne University; Carrell H. Whitnah, of Kansas State College; Thorne M. Carpenter, of the Nutrition Laboratory, West Roxbury, Mass.

Division of Agricultural and Food Chemistry: Chairman, Roy C. Newton, of Swift and Company, Chicago; *vice-chairman,* Charles N. Frey, of the Fleischmann Laboratories, New York City; *secretary,* Gerald A. Fitzgerald, of the Birdseye Laboratories, Boston; *on executive com-*

mittee, R. Adams Dutcher, of Pennsylvania State College; C. R. Fellers, of Massachusetts State College; H. R. Kraybill, of Purdue University; R. C. Sherwood, General Mills, St. Paul, Minn.

Division of Petroleum Chemistry: Chairman, Per K. Frolich, of the Standard Oil Development Company, Elizabeth, N. J.; *vice-chairman,* J. K. Roberts, of the Standard Oil Company, Chicago, Ill.; *secretary-treasurer,* Cary R. Wagner, of the Pure Oil Company, Chicago; *on executive committee,* Frank W. Hall, of The Texas Company, New York City; Jacque C. Morrell, of the Universal Oil Products Company, Chicago.

Division of Colloid Chemistry: Chairman, Lloyd H. Reyerson, of the University of Minnesota; *vice-chairman,* Ernst A. Hauser, of the Massachusetts Institute of Technology; *secretary-treasurer,* Arthur M. Buswell, of the University of Illinois; *on executive committee,* Herbert L. Davis, of the Institute of Paper Chemistry, Appleton, Wis.; Robert C. Williams, of the Ironsides Company, Columbus, Ohio; Geoffrey E. Cunningham, of Clarkson College of Technology, Potsdam, N. Y.; Ross A. Gortner, of the University of Minnesota; Wesley G. France, of Ohio State University; E. J. Miller, of the Michigan Agricultural Experiment Station, East Lansing, Mich.

Division of Cellulose Chemistry: Chairman, George L. Clark, of the University of Illinois; *vice-chairman,* Melville L. Wolfrom, of Ohio State University; *secretary-treasurer,* William O. Kenyon, of the Eastman Kodak Company; *on executive committee,* Elwin E. Harris, of the Forest Products Laboratory, Madison, Wis.; William F. Henderson, of the Visking Corporation, Chicago.

Division of Rubber Chemistry: Chairman, G. K. Hinshaw, of the Goodyear Tire and Rubber Company, Akron, Ohio; *vice-chairman,* E. B. Curtiss, of R. T. Vanderbilt Company, New York City; *secretary,* Howard I. Cramer, of the University of Akron; *treasurer,* C. W. Christensen, of the Rubber Service Laboratories, Akron; *executive committee,* Archie R. Kemp, of the Bell Telephone Laboratories, New York City; James C. Walton, of the Boston Woven Hose and Rubber Company, Boston; Arthur W. Carpenter, of the B. F. Goodrich Company, Akron; George S. Haslam, New Jersey Zinc Company, Palmerton, Pa.; W. G. Nelson, United States Rubber Company, Detroit, Mich.; Carroll C. Davis, of the Boston Woven Hose and Rubber Company; Seward G. Byam, of E. I. du Pont de Nemours and Company.

Division of Sugar Chemistry and Technology: Chairman, A. R. Nees, of the Great Western Sugar Company, Denver, Colo.; *vice-chairman,* James M. Brown, of the Revere Sugar Refinery, Charlestown, Mass.; *secretary-treasurer,* Edgar W. Rice, of the National Sugar Refining Company of New Jersey, New York City; *on executive committee,* Horace S. Isbell, of the National Bureau of Standards, Washington, D. C.; John C. Keane, of the Utah-Idaho Sugar Company, Salt Lake City, Utah; Raymond M. Hann, of the National Institute of Health, Washington, D. C.; Carl C. Kesler, of Penick and Ford, Cedar Rapids, Iowa; Marshall T. Sanders, of the Atlas Powder Company, Wilmington, Del.

Division of Microchemistry: Chairman, Lawrence T. Hallett, of the Eastman Kodak Company; *vice-chairman,* Clyde W. Mason, of Cornell University; *secretary-treasurer,* George L. Royer, of the Calco Chemical Company, Bound Brook, N. J.; *on executive committee,* Frank Schneider, of Rutgers University; Walter R. Kirner, of the Carnegie Institute of Technology, Pittsburgh.

Division of Paint and Varnish Chemistry: Chairman, William H. Gardner, of the Polytechnic Institute, Brooklyn, N. Y.; *chairman-elect,* Edwin J. Probeck, of the Jones-Dabney Varnish Company, Louisville, Ky.; *secretary-treasurer,* G. G. Sward, of the National Paint, Varnish, and Lacquer Association, Washington, D. C.; *on executive committee,* E. E. Ware, of the Sherwin-Williams Company, Cleveland; Gordon M. Kline, of the National Bureau of Standards, Washington, D. C.; Lawrence K. Scott, of the Jones-Dabney Varnish Company.

Division of Gas and Fuel Chemistry: Chairman, Frank H. Reed, of the Illinois Geological Survey; Urbana, Ill.; *vice-chairman,* H. C. Hottel, of the Massachusetts Institute of Technology; *secretary-treasurer,* Gilbert Thiessen, of the Koppers Company, Pittsburgh; *on executive committee,* R. E. Gilmore, of the Canadian Bureau of Mines, Ottawa; O. O. Malleis, of the Appalachian Coals Company, Cincinnati.

Division of Fertilizer Chemistry: Chairman, Egbert W. Magruder, of the F. S. Royster Guano Company, Norfolk, Va.; *secretary,* H. B. Siems, of Swift and Company Fertilizer Works, Chicago; *on executive committee,* F. B. Carpenter, of the Virginia-Carolina Chemical Corporation, Richmond, Va.; H. R. Kraybill, of Purdue University; F. W. Parker, of the du Pont Ammonia Corporation, Wilmington, Del.; W. H. Ross, of the Bureau of Chemistry and Soils, Washington, D. C.

Division of Water, Sewage, and Sanitation Chemistry: Chairman, A. P. Black, of the University of Florida; *vice-chairman,* O. M. Smith, of the Oklahoma Agricultural and Mechanical College; *secretary-treasurer,* Charles R. Hoover, of Wesleyan University; *on executive committee,* R. C. Bardwell, of the Chesapeake and Ohio Railway Company, Richmond, Va.; Louis F. Warrick, State Board of Health, Madison, Wis.

Division of the History of Chemistry: Chairman, Tenney L. Davis, of the Massachusetts Institute of Technology; *secretary,* Mildred W. Grafflin, of the Hercules Experiment Station, Wilmington, Del.; *on executive committee,* Charles A. Browne, of the U. S. Bureau of Chemistry and Soils, Washington, D. C.; Frank B. Dains, of the University of Kansas; Claude K. Deischer, of the University of Pennsylvania.

Division of Chemical Education: Chairman, Martin V. McGill, of Lorain High School, Lorain, Ohio; *vice-chairman,* Stuart R. Brinkley, of Yale University; *secretary,* Norris W. Rakestraw, of Brown University; *treasurer,* Virginia Bartow, of the University of Illinois; *on executive committee,* B. C. Hendricks, of the University of Nebraska; W. T. Read, of Rutgers University; Otto Reinmuth, of the University of Chicago; O. M. Smith, of Oklahoma Agricultural and Mechanical College.

The group of divisional officers elected Professor George Scatchard, of the Massachusetts Institute of

Technology, as chairman, and Professor Norris W. Rakestraw, of Brown University, as secretary.

Professors John E. Ricci, of New York University; Vincent du Vigneaud, of Cornell University Medical School, and H. B. Vickery, of the Connecticut Agricultural Experiment Station, were elected to five-year terms as associate editors of the *Journal of the American Chemical Society*, while Professor Linus C. Pauling, of the California Institute of Technology, and Dr. George S. Whitby, of the National Research Council, Ottawa, Canada, were reelected as associate editors. Professor Moses Gomberg, of the University of Michigan, was chosen to fill the vacancy caused by the death of Elmer P. Kohler.

Three reelected as associate editors of *Technological Monographs* were: Dr. Walter A. Schmidt, president of the Western Precipitation Company, Los Angeles; Dr. Edward R. Weidlein, director of the Mellon Institute of Industrial Research, Pittsburgh; Fred C. Zeisberg, of E. I. du Pont de Nemours and Company.

W. A. Noyes, Jr., professor in the University of Rochester, becomes editor-in-chief of *Chemical Reviews* on January 1, succeeding Dr. Gerald L. Wendt, of New York City. Named associate editors were: W. S. Calcott, of the du Pont Company; Professor Wendell M. Latimer, of the University of California; Professor W. Conrad Fernelius, of Ohio State University.

New associate editors of the *Journal of Physical Chemistry* are Professor George S. Parks, of Stanford University, and Professor George Glockler, of the University of Minnesota.

Dr. Beverly L. Clarke, of the Bell Telephone Laboratories, New York City, and Thomas R. Cunningham, of the Union Carbide and Carbon Research Laboratories, Niagara Falls, N. Y., were reelected associate editors of the Analytical Edition of *Industrial and Engineering Chemistry*.

Dr. Walter A. Schmidt, of Los Angeles, was named again to the society's Council Committee on Policy for three years.

SPECIAL ARTICLES

HOST-PARASITE INTERACTIONS WITH BACTERIAL WILT OF MAIZE[1]

IT is commonly believed that bacterial virulence in disease is maintained or enhanced by host passage. The constitution of the host is considered to play little part in the ultimate virulence attained. In conformity with Wellhausen's[2] recent studies I propose to show by another technique that such is not always the case.

Virulent strains of *Bacterium stewartii* (E.F.S.) Stevens, (*Phytomonas stewartii* (E.F.S.) Bergey, *et al.*), a vascular, bacterial wilt disease of maize, are characterized by colonies that are large, smooth, spreading and of a mucoid type; avirulent strains are smaller, slightly rough, raised and of a non-mucoid type. Each strain arising from single-cell isolations is constant for colony type and virulence, so that morphological characters may be used to separate individuals with different physiological potentialities.

Mixtures of virulent and avirulent bacteria of varying but known proportions were inoculated into resistant and susceptible inbred lines of maize by injecting the organisms into the growing points of seven-day-old maize seedlings with a hypodermic syringe and needle. The subsequent proportions of virulent to avirulent types may be followed by isolating at suitable intervals of time from the host. For each isolation, lesions from 10 or more plants were macerated together in a small quantity of sterile water and dilution plates poured from this liquid. In order that colony morphology could be classified, only surface smeared plates were used. In six experiments isolations were made each 4 days after inoculation; in seven other experiments isolations were made only at the end of the experiment. Total passage time varied from 14 to 20 days.

There is a correlation of $r = 0.95 \pm 0.02$ between the ratio of virulent and avirulent bacteria in the inoculating suspension and the ratio obtained by isolating from the first definite lesion. This shows that the bacteria which actually grow and produce a diseased condition are reliably estimated by plating directly from the inoculating medium.

Upon passage through the susceptible host there is a differential selection for the avirulent type of bacteria. For example, beginning with a 50–50 proportion of virulent to avirulent bacteria, the proportion observed after a 15-day passage averaged 39–61. The rate of this change during host passage is dependent upon the initial proportion of virulent to avirulent bacteria in the inoculating medium. The rate of change is slow in a population containing a high proportion of avirulent organisms. When these rates of change are plotted against the initial proportion of avirulent bacteria in the inoculating medium, the slope or regression of these rates is linear and equal to -1.1 (Fig. 1—line A).

Passage through the resistant host results in a differential selection for the virulent type of bacteria, instead

[1] Journal Paper No. J-596 of the Iowa Agricultural Experiment Station, Genetics Section, Project 404.

[2] E. J. Wellhausen, *Phytopath.*, 27: 1070–1089, 1937.

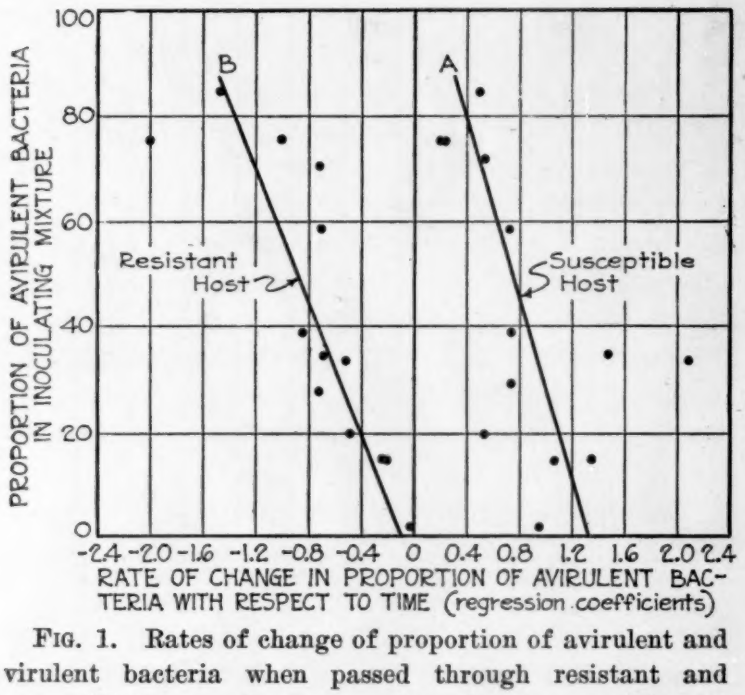

FIG. 1. Rates of change of proportion of avirulent and virulent bacteria when passed through resistant and susceptible hosts. On passage through the susceptible host the change toward a higher proportion of avirulent types is slow in a bacterial mixture composed largely of avirulent types (line A)—passed through the resistant host the change toward a lower proportion of avirulent types is rapid (line B).

of the avirulent as in the experiment above. When the initial proportion of virulent to avirulent bacteria was 50–50, the proportion observed after a 15-day passage averaged 63–37. The inoculum containing a high proportion of virulent organisms changes at a slow rate toward the limit of 100 per cent. virulent organisms. The inoculum containing a low proportion of virulent organism changes rapidly toward one of higher proportions. Again, plotting these rates of change during passage against the initial proportion of avirulent bacteria in the inoculating medium, the slope of these ratios is linear and equal to -1.7 (Fig. 1—line B).

Changes in the proportions of the virulent and avirulent types of bacteria proceed in orderly fashion from the time of inoculation to the death of the host, the direction of the change depending on the host.

Virulent bacteria kill the susceptible host in from 10 to 15 days, but only stunt the resistant host. Avirulent bacteria stunt but do not kill the susceptible host and become limited to the first early lesions in the resistant host. Assuming, as a working hypothesis, that the most advantageous host-parasite relation is one of equilibrium with a virulence sufficient to overcome host resistance, yet not so virulent as to kill the host, then selection within the micro-environment of the host over long periods of time would be towards such equilibrium. This point is approached in the low degree of virulence of bacteria adapted to the susceptible host and in the high degree of virulence in resistant maize.

With the materials used in these experiments, the rate of change in the bacterial population proceeded more rapidly within the resistant host than within the susceptible host as shown by the slope of the general regression lines (Fig. 1). The rate of change in the population is not a constant, but changes as the population changes, being rapid when equilibrium is greatly disturbed, weakening as equilibrium is approached.

The conclusion that intensity and direction of selection are dependent upon host resistance has been verified through using 14 other inbred lines of maize as host.

RALPH E. LINCOLN

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A SIMPLE TECHNIQUE FOR CONTROLLING SUBJECTIVE ATTITUDES IN SALIVARY CONDITIONING OF ADULT HUMAN SUBJECTS

IN the last six years the writer has been engaged in a series of experiments on salivary conditioning in adult human subjects. The method used for measuring the saliva consisted of weighing increments in dental cotton rolls (Johnson and Johnson, No. 3, 0.5×1.5 in.) inserted under the subjects' tongues for short periods of time, usually one minute. Since the cotton-in-the-mouth was by no means a totally inactive stimulus, periods of control salivation had to be temporally rotated with experimental periods, and, again, to prevent evaporation, scale-corrosion and absorption, the rolls had to be weighed in small envelopes and reweighed in the envelopes immediately after the removal of the rolls from the subjects' mouths. The method of measuring by itself proved to be quite satisfactory and reliable—the magnitudes of the S.D.'s of the salivations in 20 to 30 trials under uniform conditions being seldom greater than one eighth of the magnitudes of the means—but the conditioning was irregular and rather unsuccessful, despite the fact that the writer followed closely the general methodology of Russian investigators with animals.[1, 2] A statistical analysis of the data and an introspective check clearly revealed that the disturbing factors in the writer's[3, 4, 5] conditioning experiments were the subjects' sets and attitudes, their "catching on" after a few trials to "what is expected" or "what is not expected" of them. These attitudes

[1] I. P. Pavlov, "Conditioned Reflexes." Oxford University Press, 1927. Pp. xv + 430.

[2] N. A. Podkopaev, "The Methodology of Investigating Conditioned Reflexes." Moscow: GIZ, 1926. Pp. 64.

[3] G. H. S. Razran, *Arch. Psychol.*, 28: 191, 124, 1935.

[4] G. H. S. Razran, *Jour. Psychol.*, 2: 327–337, 1936.

[5] G. H. S. Razran, Studies in configural conditioning. I. Historical and preliminary experimentation. (In press, *Jour. Gen. Psychol.*) II. The effects of task-sets and subjects attitudes upon configural conditioning, *Jour. Exp. Psychol.*, 24: 95–105, 1939. III. The factors of similarity,

produced irregularity and sporadicity in the acquisition of the salivary conditioning, interfered with its progressive extinction in non-reinforced trials, and in general masked a number of otherwise established conditioning attributes. While attitudes as variables are in themselves of considerable interest and while it may very well be that "conditioning with attitudes" parallels human life-situations, it still is, of course, apparent that they must be ruled out when the properties of conditioning *as such* are to be studied.

In the last three years the writer has, therefore, used a method which is comparatively free from this incubus of subjective interferences. The method may be called the "seriate-continuous-and-misinform" technique. It consists of presenting a *series* of conditioned stimuli rather than a single stimulus during comparatively long continuous eating periods and misinforming the subjects about the purpose of the experiment. Thus, in one study the eating periods—small pretzels, tea-sandwiches, lollipops or chewing gum—were of 2-minute duration, in the course of which 40 intermittent flashes of colored lights were presented. The subjects were told that the purpose of the experiment was to "find out the effect of eye-fatigue upon digestion." In another investigation in which musical chords were the stimuli-to-be-conditioned the eating period lasted for 4 minutes and the influence of music on digestion was offered as the experimenter's real objective. In a third experiment with nonsense syllables a pure conditioned salivation set-up was disguised as a seemingly *bona fide* memory problem, while in a fourth study eating and conditioning were successfully combined with hypothetical solutions of electrical mazes. Thirty-six subjects were used in these experiments and 5 to 10 experimental sessions of 1 to 3 hours' duration were made with each subject. However, so far not a single subject has shown any evidence of any *conscious* associative set between the feedings and the stimuli given during their action in the sense that he thought that he was *expected* to secrete or not to secrete saliva when the stimuli were on; the conscious task-set was merely directed elsewhere—digestion, memorization, maze solution—and was non-functional for the particular association. At any rate, the conditionings were in all these cases highly successful and strikingly conforming with Pavlov's main behavioral findings in acquistion, extinction, spontaneous recovery, generalization, differentiation, and the like.

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proximity and continuity in configural conditioning. (In press, *Jour. Exp. Psychol.*) IV. Gestalt organization and configural conditioning, *Jour. Psychol.*, 7: 3–16, 1939. V. Generalization and transposition. (In press. *Jour. Genet. Psychol.*) VI. Comparative extinction and forgetting of pattern and single stimulus conditioning. (In press, *Jour. Exp. Psychol.*)

THE CULTIVATION OF TRITRICHOMONAS FOETUS IN DEVELOPING CHICKEN EGGS

RECENTLY a considerable number of viruses have been propagated in developing chicken embryos and in their extra-embryonic membranes; Zia (1934)[1] has reported similar cultivation of a *Rickettsia*; and the chorio-allantoic membrane of avian eggs is a favorite position for tissue grafts in experimental embryology. However, there is apparently no record of protozoa ever having been cultivated in developing eggs. The investigation here reported was designed to ascertain the possibility of propagating certain protozoa in this environment.

The strain of *Tritrichomonas foetus* which was used was obtained in bacteria-free culture on Ringer's-egg-serum medium[2] by one of us (N. D. L.) from a case of bovine abortion in an Illinois herd of dairy cattle. The eggs were obtained from a breeding flock of White Rock chickens free from infectious diseases.

Eggs which after incubation for periods of 8 to 16 days showed strong vigorous embryos were used. Then the technique described by Brandly[3] for propagation of laryngotracheitis virus was employed with the necessary modification of introducing the inoculum into the allantoic sac instead of upon or within the chorio-allantoic membrane. Following inoculation, the opening is closed with Cellophane or cellulose tape and the eggs are returned to the incubator.

In examining the eggs, the shell over the air-sac and the shell membranes are removed aseptically, and some allantoic fluid drawn off with a sterile pipette and examined under a microscope. Trichomonads may not be demonstrated in all eggs inoculated with suitable cultures. Unsatisfactory introduction of inoculum is considered to account only in part for this variation. Furthermore, trichomonads, when present, may vary in numbers from less than one to several hundred per field under the 16 mm objective. Usually, transfers were made only from those eggs in which the trichomonads were abundant.

There is no doubt that the protozoa actually multiply in the eggs, rather than merely survive. Twenty-two serial transfers from egg to egg of bacteria-free protozoa have been made over a period of about three months, with a multiplication factor of about 30 at each transfer. The eggs are opened and examined two or three days after inoculation, as much allantoic fluid as possible being saved in sterile test-tubes. Five or more cc may be obtained from one egg, although usually about 2 cc are readily recoverable. If bacteriologically sterile, the fluid is used for the inoculation of another series of eggs. The trichomonads will survive in allantoic fluid placed in cotton-plugged test-

[1] S. Zia, *Am. Jour. Path.*, 10: 211, 1934.
[2] C. W. Rees, *Am. Jour. Hyg.*, 26: 283, 1937.
[3] C. A. Brandly, *Jour. Infect. Diseases*, 57: 201, 1935.

tubes for several days at room temperatures, but in the egg, death of the embryo may be followed very shortly by mortality of the protozoa.

No pathogenic action by these protozoa on the chick embryo has ever been noted. If left in the incubator for the full incubation period, normal chicks hatch out. Trichomonads are no longer present, since the allantoic fluid has disappeared.

It is apparently not necessary for the trichomonads to be entirely free of bacteria in order to multiply in the allantoic fluid, since the presence of saprophytic air-contaminants has been found not to prevent their development. If, however, the bacteria kill the chick embryo, the trichomonads die in a day or two.

Preliminary series of experiments indicate that eggs which have been incubated about 12 days are more satisfactory for cultivation of *Tritrichomonas foetus* than eggs incubated for shorter or longer periods. An incubation temperature of 37° C. is better than 34.5° C. or 39° C.

Tritrichomonas muris from the rat has also been cultivated in developing eggs, but no sub-cultures have been attempted to date.

Since protozoa have already been cultivated in artificial culture media and in tissue culture, the use of developing chicken eggs offers a third type of medium which may prove of value in experimental propagation studies.

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THE PRODUCTION OF GOITER IN CHICKENS[1]

ALTHOUGH goiter in poultry has been noted in iodine-deficient areas,[2] no report of its experimental production has been found. We have obtained goiter in chickens with a ration containing .145 mg per kilo of iodine, and have prevented goiter by the addition of 5 mg per kilo of iodine to the same ration.

Five hundred White Leghorn chicks were used in the two lots. The basal ration contained 71.5 per cent. yellow corn meal, 25 per cent. soybean oil meal, 1 per cent. casein, 0.5 per cent. salt, 2 per cent. bone ash, 0.001 per cent. activated animal provitamin (50,000 units of D per gram), 0.015 per cent. manganous sulfate, and 0.03 per cent. of a salt mixture. The vitamin G requirements for growth were supplied by liquid skim milk.[3]

Thyroid weights of chickens fed the basal ration were 130 per cent. of the control thyroid weights at 6 weeks, 240 per cent. at 12 weeks and 294 per cent. at 18 weeks. In extreme cases, thyroids have been found to approximate twenty times normal weight.

Histopathological examinations of the enlarged thyroids at these intervals during growth showed an absence of colloid and a hyperplasia of the living cells of the follicles. These changes were apparent at 6 weeks and increased in severity with age. Thyroid glands from the control group remained normal.

Work on the iodine requirements of poultry is being continued.

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[2] H. Welch, *Montana Agr. Exp. Station Bulletin*, 214, 1928.

[3] G. F. Heuser, H. S. Wilgus, Jr., and L. C. Norris. *Poultry Science*, 11: 105, 1938.

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